THE MASSACHUSETTS TOXICS USE REDUCTION INSTITUTE

MEASURING PROGRESS IN TOXICS USE REDUCTION AND POLLUTION PREVENTION

Massachusetts Toxics Use Reduction Program

Technical Report No. 30 1996

University of Massachusetts Lowell

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Measuring Progress in Toxics Use Reduction and Pollution Prevention

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The Toxics Use Reduction Institute
University of Massachusetts Lowell

1996

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The Toxics Use Reduction Institute is a multi-disciplinary research, education, and policy center established by the Massachusetts Toxics Use Reduction Act of 1989. The Institute sponsors and conducts research, organizes education and training programs, and provides technical support to promote the reduction in the use of toxic chemicals or the generation of toxic chemical byproducts in industry and commerce. Further information can be obtained by writing the Toxics Use Reduction Institute, University of Massachusetts Lowell, One University Avenue, Lowell, Massachusetts 01854.

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AIM TUM	Associated Industries of Massachusetts Toxics Use Management Committee
BRI	Byproduct Reduction Index
CAS	Chemical Abstracts Service registry number
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DEP	Commonwealth of Massachusetts Department of Environmental Protection
EPCRA	Emergency Planning and Community Right-To-Know Act of 1986
ERI	Emission Reduction Index
FMF	DEP Facility Master File database
FTE	Full Time Employee
GAO	Government Accounting Office
IDEM	Indiana Department of Environmental Management
IRI	Input Reduction Index
LQTU	Large Quantity Toxic User
MA	Massachusetts
MEK	Methyl Ethyl Ketone
MGL	Massachusetts General Law
MSDS	Material Safety Data Sheet
OTA	Massachusetts Office of Technical Assistance for Toxics Use Reduction
POTW	Publicly Owned Treatment Works
PPIS	Pollution Prevention Incentives for States
PR	Production Ratio
PR_{WA}	Weighted Average Production Ratio
PU	Production Unit
QA/QC	Quality Assurance/Quality Control
RCRA	The Resource Conservation and Recovery Act
SIC	Standard Industrial Classification
TRI	Toxics Release Inventory
TUR	Toxics Use Reduction
TURA	Toxics Use Reduction Act
TURI	Massachusetts Toxics Use Reduction Institute
UOP	Unit of Product
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

Under the Massachusetts Toxics Use Reduction Act (TURA) industrial facilities have been reporting on their use of toxic chemicals and generation of hazardous byproduct (wastes) since 1990. This study was designed to develop and test a methodology for measuring toxics use reduction (TUR) progress in the Commonwealth and to apply this methodology to the collected data. Results indicate that progress is being made in reducing toxic chemical use and the generation of toxic byproducts.

Purpose of this Study

In Massachusetts the state pollution prevention program is called the Toxics Use Reduction Program (TURA). Under TURA roughly 600 industrial facilities must report annually on toxic chemicals used and toxic byproducts generated at the facility. Each year as facility managers prepare to report toxic chemicals released to the environment or transferred off-site under the federal Toxics Release Inventory (TRI) they must also report on the use of those chemicals under the state TURA program.

The state TURA law is implemented by a partnership between four state agencies: the Administrative Council on Toxics Use Reduction, the state Department of Environmental Protection (DEP), the Office of Technical Assistance (OTA), and the Toxics Use Reduction Institute (TURI) at the University of Massachusetts Lowell. Over the past several years of implementation the agencies have raised many questions about whether Massachusetts companies are making progress in toxics use reduction. This study was designed to use available data to answer those questions. The methodology was developed using the state TURA data and data from the federal TRI..

This data measurement project is part of a larger effort being conducted by the four state agencies to evaluate the success of the TURA program in Massachusetts. One specific section of the state law sets a statewide goal of 50% reduction in toxic waste (byproduct) generation by 1997 through toxics use reduction. The baseline for this metric is 1987. This study establishes a basis for evaluating progress towards meeting that goal.

Results of the Data Analysis

The results of the study indicate that Massachusetts industries made progress in toxics use reduction between 1990 and 1993. The study reached this conclusion by developing a methodology which uses the TURA and TRI data to calculate multiple metrics of progress. The

principle metrics include: both actual and production-normalized changes in quantities of toxic chemicals used, generated as byproduct, shipped in or as product, released to the environment and transferred off-site. Production-normalized metrics indicate whether observed changes are due to changes in a firm's level of production, or to the firm's TUR efforts. The production ratio or activity index reported under TRI was used as an indicator of the production level.

In order to account for changes in reporting requirements over the 1990 to 1993 period, the TURA data were evaluated in separate "universes" of consistently reportable industries and chemicals. At this point, the largest consistent universe is the "1990 Reportables." This consists of chemicals and industrial sectors (manufacturing SIC codes) reportable under the TRI in 1990. From 1990 to 1993, the following changes occurred in this 1990 Reportable universe:

- There was a 17% actual reduction and 19% normalized reduction in total use of toxic chemicals reported under TURA
- There was a 13% actual reduction and 14% normalized reduction in total byproduct generated reported under TURA
- There was a 5% actual increase and 3% normalized increase in total amount of toxic chemicals shipped in or as product reported under TURA.
- There was a 4% actual reduction and 8% normalized reduction in total toxic chemical releases and transfers reported under the TRI (Releases to the environment and transfers to sewer systems--POTW's--decreased while off-site transfers increased)

For all 1990 Reportables, the effect of normalizing for changes in production was nominal because production first decreased, then leveled off, and then increased, for a small net increase over the three year period.

Confidence in the Data Analysis

In order to establish confidence in the results of any measurement methodology, it is necessary to determine the quality of the data used. Two key components of the study addressed this issue: 1) a facility "reality check," and 2) improvement in the quality and useability of the TURA data.

The facility "reality check" was done to determine whether the TURA data being reported by companies accurately reflected toxics use reduction activities at the facilities. An in-depth investigation of several facilities in Massachusetts was performed to determine 1) confidence in reported data, 2) "best practices" for materials accounting, and 3) the effect of facility reporting problems on the measurement of progress at the state-wide level.

Results of the "reality check" indicated that facilities which used "best practices" in materials accounting had significantly more confidence in their data. While 10 of the 11 case study firms said that they had done TUR, many had low confidence in their Byproduct Reduction Index (BRI), an indicator used under TURA to assess byproduct changes against a base year.

Characteristics of "high confidence" BRI's included production units using "best practices" materials accounting, and continuous processes. Conversely, "low confidence" BRI's were characterized by production units with batch processes, difficulty selecting a correlated unit of product, small quantities of byproduct, and poor base year data.

Since the first TURA data became available, the state DEP has been working to create a high-quality database that is readily accessible to the public. This is a complex undertaking, and has required continuous improvement in data management techniques. Significant work was done under this project to identify obvious reporting and entry errors, and to identify changes to the data management system which would improve the useability of the data, particularly at the production unit level. When improvements are complete, the result will be a powerful database of information about toxics use and byproduct generation in Massachusetts, which will allow users to determine to what extent and where changes are occurring.

A thorough review of this study indicates the value of a systematic toxic chemical use and release data base for tracking pollution prevention progress. As state agencies and firms further develop their capacities to collect, analyze and use this data, the Commonwealth can, with increasing confidence, claim that pollution prevention is working in Massachusetts.

1 INTRODUCTION

1.1 Introduction

The Massachusetts Toxics Use Reduction Act (TURA) was passed in 1989 with the objective of reducing toxic chemical use and byproduct generation in the Commonwealth. The Act requires that large quantity toxics users report to the state annually on their use of toxic chemicals and byproduct generation, and that they prepare a toxics use reduction/pollution prevention plan for their facility. This study uses the data reported by facilities to determine whether Massachusetts industries are making progress in toxics use reduction.

This study was a cooperative effort by the three main TURA implementing agencies: the Toxics Use Reduction Institute (TURI), the Department of Environmental Protection (DEP) and the Office of Technical Assistance for Toxics Use Reduction (OTA). TURI is a research, policy and education center established by the Act and located at the University of Massachusetts Lowell. The DEP's Bureau of Waste Prevention oversees the gathering of data, promulgates regulations, and coordinates the Department's activities to ensure a multi-media approach. OTA provides free consultation and advice to firms seeking assistance in implementing toxics use reduction programs.

Many questions have been raised about whether Massachusetts companies are making progress in toxics use reduction. Numerous case studies describe significant chemical use and waste reduction at individual facilities. Are these facilities representative of others in their industry? The Federal Toxics Release Inventory (TRI) data has indicated a reduction in combined releases to the environment and transfers off-site. Are these reductions due to more efficient chemical use or more on-site, end-of-pipe treatment? Has TURA been effective in assisting companies to evaluate and reduce their input and output of toxic chemicals? This project is designed to answer these and many other questions about progress in Massachusetts.

The objective of this study has been to produce a tested methodology for using the Massachusetts TURA and federal Toxics Release Inventory (TRI) data for measuring state-wide progress in toxics use reduction (TUR) and pollution prevention. While TUR progress is the focus of this report and will be the terminology used throughout, it should be noted that TUR is merely a strict interpretation of pollution prevention.[1] The TURA "byproduct" quantities referred to in the report are equivalent to waste generation prior to treatment or out-of-process recycling.

The methodology was designed to provide a broad vision of progress in the Commonwealth, as well as to respond to the goals of TURA. To provide the broad vision, the methodology will use

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[1] TUR is restricted to TURA listed toxic chemicals, and includes only in-process pollution prevention activities. Thus, out-of-process (anything not hard-piped and integral to the process) recycling and waste treatment are not TUR.

multiple metrics based on toxic chemical byproduct, use, shipped in or as product, released to the environment, and transferred off-site quantities. Some of these metrics will also address specific goals of the Act. While TURA has several general policy goals, it states one numeric goal: to achieve by 1997, through toxics use reduction, a fifty percent (50%) reduction from 1987 quantities of toxic byproducts generated by industry.

1.2 Project Objectives

This project consists of five major objectives:

1) Improve the quality and useability of the TURA data.
Since the first TURA data became available, DEP has been working to create a high-quality database that is readily accessible to the public. After the first releases of the "extract files" (ASCII text files downloaded from DEP's main database system), DEP became aware of numerous issues around the accuracy and useability of the data. Accuracy issues focused particularly on 1990 data and production unit-level fields. Useability issues included problems with the extract procedure and how the data were stored in the extract files. A key objective of this project was to identify and correct as many of these issues as possible.

2) Define a methodology for measuring TUR progress using available data.
There is no established methodology for measuring pollution prevention or toxics use reduction progress. Thus, a key objective of this project was to develop a methodology using available TURA, TRI and any other applicable data.

3) Test the methodology using available data.
The proposed methodology was applied to 1990 through 1993 data in order to test the usefulness of the methodology as well as to provide an indication of TUR progress in Massachusetts.

4) Define a methodology for establishing a 1987 baseline.
TURA's 50% byproduct reduction goal establishes 1987 as the baseline from which to measure progress. This was chosen in order to include the reductions already achieved by firms prior to the passage of TURA. However, TURA reporting was not required until 1990. 1987 TRI data do not provide byproduct quantities and not all TURA industries and chemicals were required to file under TRI in 1987. Therefore, a methodology was needed to estimate the 1987 baseline quantities. It was originally planned to complete the 1987 baseline work as part of this project. However, it was decided that in order to create a statistically meaningful baseline, this portion of the project would take longer than expected. A methodology, a pilot survey and the first phase of the full survey have been completed to date. The full results are expected in April 1996.

5) Conduct a "reality check" to evaluate the validity of the reported data.
The project team felt that it was critical to determine whether the TURA data being reported by companies accurately reflected toxics use reduction activities at their facilities. A measurement methodology can only be as good as its data source. An in-depth investigation of several facilities in Massachusetts was performed to determine 1) confidence in reported data, 2) "best practices" for chemical tracking, and 3) the effect of facility reporting problems on the measurement of progress at the state-wide level.

While the three agency project team worked together to frame and carry out the work, each agency had different roles and responsibilities. TURI was responsible for overall coordination of the project and the final report. DEP and TURI shared responsibility for data quality work, TURI took the lead on the methodology and data analysis, DEP initiated the 1987 baseline work, and OTA was responsible for the "reality check" portion of the project.

1.3 TURA Program Evaluation

This project is not an isolated data analysis activity. Although it began almost a year earlier, it is the cornerstone of the TURA Program Evaluation effort begun in the summer of 1995. This larger effort aims to measure progress toward all the goals of the Act, including the numerical goal, and to assess the program's effectiveness in implementing and promoting TUR. This project has benefited from the perspective brought by the larger evaluation, particularly in terms of how to establish a 1987 baseline for measuring progress.

The results of this study should be viewed as the first step in refining a measurement methodology. We hope to receive feedback on the methodology and the results presented here from all stakeholders. This will be incorporated into the next run of the methodology in mid-1996 using both the newly available 1994 data, as well as further improved 1990 data. At that time, the 1987 baseline will also be available so that progress can be estimated from 1987 to 1994.

1.4 Organization of this Report

This report begins by setting the context for this project, both in terms of TURA's objectives and provisions and in terms of previous work on measuring pollution prevention and TUR progress. The overall project methodology is presented, followed by results for each component of the study. The report ends with conclusions drawn from the work and recommendations. The report is divided into the following sections:

- Chapter 2 provides background information on the Massachusetts Toxics Use Reduction Act and related federal legislation as well as a brief review of previous pollution prevention measurement projects.

- Chapter 3 describes the data available for measuring progress and explains some of the issues involved in using the data to develop an accurate measure.

- Chapter 4 describes the process used to identify issues related to the TURA and TRI data, progress in resolving those issues, and a schedule for continuing to improve the data and the data management system.

- Chapter 5 describes the results of the "Reality Check" analysis of TURA facility reporting efforts and the effect on the methodology of reporting problems.

- Chapter 6 describes the process and progress to date in establishing baseline TURA data for the year 1987.

- Chapter 7 describes the methodology developed using TRI and TURA data to measure toxics use reduction progress.

- Chapter 8 presents the results of the methodology using the currently available TURA data.

- Chapter 9 provides conclusions and recommendations for improving the TUR measurement methodology, the underlying data, and the practices used by the facilities to report the data.

2 BACKGROUND

KEY POINTS

- The Massachusetts Toxics Use Reduction Act (TURA) reporting requirements are similar to the federal reporting requirements under EPCRA, although TURA includes more industries and chemicals and, in some cases, has a lower reporting threshold.
- TURA requires facilities to report on the use of toxic chemicals and the generation of toxic byproducts. Facilities are also required to report some information at the production unit level.
- One of the goals of TURA is to achieve by 1997, through toxics use reduction, a 50% reduction from 1987 quantities of toxic byproducts generated by industry.
- Reporting under TURA began in 1990 so data are not directly available for 1987.
- Changes in chemical use and byproduct generation are affected by changes in production level as well as by toxics use reduction activities.
- Previous projects have developed and, in some cases, applied methodologies for measuring pollution prevention and TUR progress. Methodologies include qualitative and quantitative metrics. Methods which normalize reported quantities to account for changes in production levels have suggested the use of employment, value-added manufacture and TRI production ratio data as indicators of production.

2.1 Massachusetts Toxics Use Reduction Act

In 1989, Massachusetts passed the Toxics Use Reduction Act (TURA), which is a toxics use reduction[1] (TUR) planning and reporting law. The data on toxic chemical use and byproduct generation collected under TURA supplements waste and release information submitted under the federal Toxics Release Inventory (TRI) program. Byproduct is defined in TURA as "all non-product outputs of toxic or hazardous substances generated by a production unit, prior to handling, transfer, treatment, or release." (MGL Ch21*I*) Thus, byproduct includes not only waste material which leaves the facility boundaries, but also any material that is recycled, reused or reprocessed on-site, but outside the production process in which it is generated. Massachusetts has been collecting data under TURA since 1990.

[1]TURA defines toxics use reduction as "In-plant changes in production processes or raw materials that reduce, avoid, or eliminate the use of toxic or hazardous substances or generation of hazardous byproducts per unit of product, so as to reduce risks to the health of workers, consumers, or the environment without shifting risks between workers, consumers or parts of the environment." (MGL Ch 21*I*) See Appendix A3.

2.1.1 TURA Goals and Provisions

The key actions required by the Act are reporting and planning. Firms which qualify as a "Large Quantity Toxics User" (LQTU) must report annually to DEP on their use of toxics and generation of toxic byproducts, as described in section 2.1.2. Those same firms must establish a facility TUR team which prepares a TUR plan. The team evaluates the facility for toxics use and byproduct generation, identifies TUR options, and evaluates those options based on technical and economic feasibility as well as environmental, health, and safety impacts. TURA does not require a facility to implement any TUR options or to achieve any specific reduction goals; it only requires a facility to plan.

TURA has one numerical goal for reduction of toxic chemical byproduct generation:

> "..to achieve by 1997, through toxics use reduction, a fifty percent (50%) reduction from 1987 quantities of toxic or hazardous byproducts generated by industry in the Commonwealth of Massachusetts." (MGL Ch.21*I* §13(A))

While the 50% goal is clear, there are differing opinions about exactly how to measure progress toward the goal. One interpretation is that there should be a 50% reduction in the quantity of toxic chemical byproducts generated in Massachusetts, regardless of the cause of reduction. Another interpretation is that the reduction must be achieved through toxics use reduction techniques, not through other causes, such as changes in production levels. In addition, a policy goal of the Act[2] (Massachusetts Laws of 1989, Ch. 265 §1), is "to promote reductions in the *production and use* of toxic and hazardous substances within the Commonwealth" [italics added]. Each of these interpretations requires a different metric for determining progress. This report considers metrics that address each of these goals and interpretations, as well as metrics which help to understand the reasons behind the overall trends which are observed.

2.1.2 TURA Reporting Requirements

Facilities are required to report under TURA if they:

- have ten or more full time employees,
- are included in Standard Industrial Classification (SIC) codes 20-39 (beginning with 1990 reporting year) or 10-14, 40, 44-51, 72-73 or 75-76 (beginning with 1991 reporting year), and

[2] The "Act" (Massachusetts Laws of 1989, Ch. 265) is the law that was passed making TURA part of the Massachusetts General Law (Chapter 21*I*). The "Act" consists of: the policy goals of the Act, the section which inserts TURA as MGL Ch. 21*I*, and other sections which insert supporting paragraphs into other parts of MGL.

- manufacture or process 25,000 pounds or more per year or otherwise use 10,000 pounds or more per year of a TURA listed chemical (if a facility trips the threshold for one chemical, it must report on all chemicals used in excess of 10,000 pounds per year).

Chemicals covered under TURA for the 1990 reporting year are identical to those on the EPCRA[3] or Toxics Release Inventory (TRI) list for 1990. The list of chemicals expanded from 1991 through 1993 by the phasing in of chemicals regulated under CERCLA[4]. One third of the 731 CERCLA chemicals were added each year from 1990 to 1993, although many were already included in the EPCRA list (see Appendix B). While the EPCRA list formed the basis for the TURA list, TURA does not automatically delist a chemical delisted by EPCRA.

The reporting requirements include submitting a Form S, a Form S Coversheet, and a federal Form R. These must be submitted for each of the reportable chemicals described above. The information required on the Massachusetts forms is outlined below. The information required on the federal Form R is outlined in section 2.2. Appendix A contains detailed information on the TURA Form S and reporting requirements.

On the Form S and Coversheet, firms are required to provide information both at the facility level and at the production unit level for each listed chemical. At the facility level, firms are required to report total pounds of each listed chemical manufactured, processed, otherwise used, generated as byproduct, and shipped in product.

At the production unit level, firms must provide the following information:

- a description of the production unit and product,
- the SIC code(s) relating to that production unit,
- the quantity of chemical used, expressed as a range and entered as a code,
- a byproduct reduction index (BRI),
- an emission reduction index (ERI), and
- codes describing the TUR techniques used during the reporting year.

The BRI is of particular interest to this study. The BRI is a measure of the reduction in chemical byproduct generation <u>per unit of product</u>, in the current year relative to a base year. Thus, the BRI factors out changes in byproduct due to changes in production levels. It is, therefore, a measure of toxics use reduction. The ERI is a similar index for emissions reduction, also normalized for production. It should be noted that when a chemical is used in more than one production unit, separate BRIs and ERIs are reported for each production unit while the total chemical quantities are reported for the entire facility, not for separate production units. As a result, it is not possible to apportion any reported chemical quantities (use, byproduct, shipped in

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[3] Emergency Planning and Community Right to Know Act of 1986

[4] Comprehensive Environmental Response, Compensation, and Liability Act of 1980

product, or TRI releases and transfers) to any production unit. Nor is it possible to determine an overall byproduct reduction index for the total amount of a chemical used by a facility. This "data gap" caused by reporting quantities only at the facility level is an intentional gap requested by industry to protect business information and is specified in the TURA legislation.

More detailed information about the TURA data elements is included in Appendix A. In addition, later discussions of data availability and useability in Sections 3.2 and 3.3 provide an in-depth look at the TURA Form S data.

Facilities are also required to submit a summary of the TUR team plan to reduce the use of toxics and generation of toxic byproducts. Firms were first required to prepare plans in 1993 and submit the corresponding plan summaries to DEP in July 1994. The plan summaries include projections of future toxic use and byproduct generation, based on anticipated TUR activities and must be submitted biennially.

2.2 EPCRA, TRI and the Federal Pollution Prevention Act

The provisions of EPCRA mandated the US Environmental Protection Agency (EPA) to create a nationwide inventory on the release and transfer of toxic chemicals by industrial manufacturing facilities. The information is reported by facilities on the federal Form R and has been compiled into a database known as the Toxics Release Inventory (TRI). The largest users of toxic chemicals were first required to report in 1988 on 1987 releases and transfers. Smaller facilities were phased in over reporting years 1988 and 1989. Chemicals listed under EPCRA in 1990 include 302 chemicals and 20 categories of chemicals. This list is subject to revision as part of EPA's ongoing review process. The Pollution Prevention Act of 1990 expanded the TRI to include additional reporting on waste management and pollution prevention activities.

TRI Reporting criteria are the same as for TURA, with the following exceptions. For TRI:

- only manufacturing facilities in SIC codes 20-39 are covered,
- only the EPCRA list of chemicals is covered, and
- threshold amounts for reporting remain constant (i.e., manufactured or processed chemicals < 25,000 pounds per year are never reported).

Thus, a facility may have to file under TURA and not TRI, but the reverse is never true. If a facility has to file under TURA, they must submit a Form R to the Massachusetts DEP, even if they are not required to submit one to the EPA under TRI.

On the Form R, facilities report the quantities of listed chemicals released to the environment, transferred off-site, and both on- and off-site energy recovery, recycling, and treatment. The quantities are reported as facility level totals and are reported for the previous year, the current year and projected for one and two years in the future. Release and transfer data have been reported since 1987. The source reduction and recycling (Section 8) elements were added for reporting year 1991. Theoretically, the sum of Section 8 quantities at any facility should equal TURA byproduct. In reality, there is a poor correlation between them (Tellus, 1995). One known discrepancy is when in-process recycling is reported as "on-site recycling" in TRI Section 8, but is not reported as TURA byproduct. Also, when a facility claims trade secret under TURA, no information is included in the TURA extract files about that chemical, whereas their release and transfer data are included in the TRI database. There also may be other types of differences in reporting which contribute to the poor correlation. That particular issue was not investigated during this study.

In addition to these quantities, companies report a production ratio (PR) or activity index for each chemical. The PR is a measure of the level of production in the reporting year compared to the production level in the previous year. Appendix D and Chapter 3 contain detailed information regarding TRI reporting.

2.3 Description of Previous Measurement Work

This section will provide a brief summary of the existing body of knowledge around measuring progress in pollution prevention and toxics use reduction. It will look only at those methodologies applicable to progress at the state or national level, as opposed to the facility level. The focus of each study and any significant and relevant conclusions are presented below. In some cases additional information is included in the appendices.

2.3.1 Pollution Prevention Measurement

A variety of work has been done by EPA and states to measure pollution prevention progress. It has ranged from the very qualitative (e.g., anecdotal information about cost savings and waste reduction) to quantitative, (e.g., data analysis of chemical release and transfer trends). A few of the more relevant projects will be described here.

2.3.1.1 EPA Measurement Project

Four states, Washington, Oregon, Alaska, and Ohio, are taking part in the EPA Measurement Project and are using TRI data in their projects to assess pollution prevention measurement. In some cases these data have been supplemented by state-mandated data, e.g., Oregon and Washington planning data, or by other federal databases such as RCRA Biennial Reporting System data.

Washington's data analysis methodology development consists of an assessment of both actual releases and normalized measures using production data (provided on state P2 plans), number of employees, and total revenue. The main data sources include facility P2 plans, TRI and RCRA data.

2.3.1.2 Washington State Normalization Study

In 1991, Tellus Institute and others (Tellus Institute, et al, 1991) completed a study for the state of Washington which proposed a methodology for normalizing data to account for production level. The study evaluated available data sources and suggested using both employment and gross income as proxies for output (production level).

A related finding of the study was the unreliability of 3- and 4-digit SIC codes. A test case using the paper industry found that the same facilities were categorized into different SIC codes by different state and federal agencies (US EPA, US Department of Commerce Census Bureau, Washington Department of Ecology, etc.). This variation in how SIC codes are interpreted makes it difficult to obtain comparable data from different sources for normalized industry analysis.

2.3.1.3 Indiana Report

In 1994, the Indiana Department of Environmental Management (IDEM) issued its First Annual Report on Pollution Prevention Progress (Indiana, 1994). Indiana's program consists of a non-regulatory, university-based institute and a regulatory office within IDEM. Their P2 legislation provided for technical assistance and training, but did not require additional reporting or planning by companies. Indiana's definition of P2 is similar to MA TURA, in that it is restricted to in-process activities. Their annual report established a quantitative measure of progress and evaluated their program activities and accomplishments.

The Indiana quantitative measure used the source reduction data from TRI Form R, submitted for reporting year 1991, which provides data for 1990 and 1991, as well as projected estimates for 1992 and 1993. They tracked "total generation," defined as all Section 8 quantities, and "total generation less on-site recycling," because they could not determine whether specific on-site recycling quantities were due to P2 or not. They also calculated a weighted average Production Ratio/Activity Index for 1990 to 1991, using it to calculate "adjusted" 1991 quantities.

Results indicated a reduction in "total generation" from 90 to 91 of 8-1/2%, despite an 8% increase in production levels. It was also noted that nearly one half of the 8-1/2% reduction (55 million pounds) was the result of reduced on-site recycling of sulfuric acid by one facility, caused by lower production rates. The estimated quantities for 1992 and 1993 showed no further significant reductions expected from 1991. While the study put forth a credible methodology using the TRI data, it was difficult to test it with only one year's reporting data available.

2.3.2 Toxics Use Reduction Measurement

Pollution prevention measurement efforts have varied in their definition of P2 and in their focus. In Massachusetts, P2 is defined specifically as TUR. In 1991, work began on developing measurement techniques that would take advantage of the data being collected under TURA and focus on the goals of TURA.

2.3.2.1 The Tufts Capstone Report - *Measuring Progress in Toxics Use Reduction*

In 1991, the Massachusetts Department of Environmental Protection (DEP) commissioned a group of Tufts graduate students to prepare a study of the options available for measuring progress in toxics use reduction. (Harriman, et al, 1991) The group looked at the data that would be available from various sources and evaluated potential methodologies for measuring progress. The study was done just prior to the time that the first Form S reports were due (July 1991) and, therefore, before any data actually were available. Potential sources of data and existing methodologies were reviewed and evaluated.

The study, *Measuring Progress in Toxics Use Reduction*, concluded that the most meaningful results would be obtained by using multiple indicators of progress, including both actual quantity reductions and reductions normalized to account for changes in production. For normalized measures, the report recommended that additional information, a facility-wide BRI, be required on the TURA Form S. Given that a facility-wide BRI might not be available, the study recommended using employment, possibly adjusted for changes in worker productivity, or "value-added manufacture" as an indicator of state-wide production levels. Further research was suggested to study the effect of changes in worker productivity and the other confounding factors on the validity of employment as an indicator. It was noted that "value-added manufacture" data are available only every five years and with a two to three year lag time, and so are of limited usefulness. (See Appendix E)

2.3.2.2 The Tellus Report - *Taking Stock: Measuring Toxics Use Reduction Progress in Massachusetts*

In 1994, TURI contracted with Tellus Institute to do a measuring progress study as background work for the second chemical restrictions report (see next section). The objective of this study was to use previous work on measuring progress to tailor a methodology for measuring TUR progress in Massachusetts. The report, *Taking Stock: Measuring Toxics Use Reduction Progress in Massachusetts* (Tellus, 1995), provided an overview of previous work, determined which types of metrics were most applicable to the Massachusetts goals and data, and then tested the methodology on five industry sectors using 1990 to 1992 TURA data. This was the first attempt to do an extensive analysis using the TURA data and much was learned from the experience. The findings relevant to this study are outlined below.

The study proposed a methodology consisting of the following metrics:

1) Qualitative Methods: Examine positive vs. negative BRI's and ERI's, explanation codes for chemicals previously reported but not reported in current year, TUR technique codes, and Form R source reduction activity codes.

2) Non-normalized Quantitative Methods: Calculate total use, byproduct, shipped in product, and TRI release, recycle and transfer quantities.

3) Normalized Quantitative Methods: Calculate quantities as in 2), but adjust for the level of production using state-wide employment and, when available in the future, value added data. Monthly employment data are available for Massachusetts at the 4-digit SIC code level. It was not recommended to adjust employment for changes in productivity, because these statistics are not considered to be highly reliable and are not available for all 4-digit SIC codes, nor for Massachusetts alone.

This methodology was then applied to five industry sectors. The following significant conclusions were drawn from the study (Tellus, 1995 and Shapiro and Harriman, 1995):

- Analysis of the TURA data at the 4-digit SIC level can be seriously affected by data errors or reporting anomalies at one or a few facilities.
- It is not possible to discern trends from only three years of data. (Only 1990 through 1992 were available at that time.)
- Qualitative data are useful primarily as supporting evidence for quantitative results. That is, they can support (or not support) observed trends in the data but do not reliably demonstrate trends themselves.
- Changes in reporting requirements under TURA must be accounted for to accurately assess progress.
- There are significant discrepancies between byproduct as reported under TURA and the sum of TRI quantities which are expected to equal TURA byproduct.
- The use of employment as a proxy for production was inconclusive, at best. Changes in employment for each SIC were small (1-7%) and did not always correlate with changes in number of facilities, chemicals or production units.

2.3.2.3 Chemical Restrictions II - The Massachusetts Experience with TUR

TURA required the Toxics Use Reduction Institute (TURI) to complete "a further study on the Massachusetts experience with this chapter [TURA] and how it relates to the issue of chemical restrictions." (MGL Ch.21*I*) The report, *Toxic Chemical Management in Massachusetts: The*

Second Report on Further Chemical Restriction Policies, (Geiser and Rossi, 1995) was published in January of 1995. It examined the Commonwealth's experience, in part, by looking at industry's progress under the Act.

The report utilized the work done by Tellus and additional work by TURI to draw a preliminary picture of progress using 1990 through 1993 data. The objective was to ascertain whether progress was occurring under TURA and for which chemicals, groups of chemicals, and industries.

This preliminary look at state-wide progress showed a reduction in total chemical use of approximately 6% and a reduction in byproduct of 16%, utilizing a "refined" set of data. In addition, it was noted that trends in certain categories of chemicals, particularly ozone-depleting substances being phased-out under the Montreal Protocol, showed greater reductions than in others.

2.3.3 Summary of Previous Measurement Work

The methodology development for this study built on the previous work described in this section. Key findings which were incorporated into the methodology include the following:

- multiple metrics provide a more complete measure of progress
- further study is necessary around normalization methods based on BRI, employment or TRI production ratio
- changes in reporting requirements must be accounted for by creating consistent subsets of chemicals and industries
- data quality issues may seriously impact measurement of progress at industry or chemical level

3 METHODOLOGY - DATA OVERVIEW

KEY POINTS

- Various types of data are needed to effectively measure TUR progress. These include chemical quantities, as well as indicators of production, which will be used to normalize quantities for changes in level of production.
- Toxic chemical use, byproduct and shipped in product quantities provided under TURA are essential to a meaningful TUR measurement methodology. TURA quantities available for use in the methodology include quantity of toxic chemical manufactured, processed, otherwise used, generated as byproduct, and shipped in or as products.
- TRI data available for measuring progress include releases and transfers of toxic chemicals.
- Production data which could potentially be used for normalizing quantities include: industry employment, worker productivity, value-added manufacture, TRI production ratio and TURA BRI/ERI.
- Employment data was eliminated as a potential indicator because it does not appear to follow production levels well and because it can not be easily adjusted for changes in worker productivity. Value-added data were eliminated because of the lag time in their availability.
- The best available proxies for production levels were determined to be the TRI production ratio and unit of product information incorporated into facility BRI's.
- TURA reporting requirements were phased in over four years. This requires that the methodology accommodate a constantly changing universe of reportable chemicals and industries.
- In order to calculate progress from a 1987 baseline, data must be estimated and/or additional data must be collected from facilities for 1987 through the first year reporting was required.
- Data availability is also affected by facilities which drop below or rise above reporting thresholds.
- Toxic chemical quantities are reported at the facility level, while BRI's, ERI's, SIC codes, and other data are reported at the production unit level. While both facility-wide quantity data and production unit level information are useful individually for measuring progress, it is not possible to quantitatively link the two sets of data. This prevents the calculation of a facility- or state-wide aggregated BRI and limits the ability to calculate industry-wide measures of progress.

3.1 Introduction

The first step in developing a measurement methodology is to evaluate the potential data sources that are available. This chapter outlines the types of data required to measure TUR progress and evaluates their availability, useability, and overall quality. These evaluations build on the previous work described in Chapter 2, beginning with assumptions about what sources of information are likely to be applicable. The results of this evaluation will determine the most effective strategies for measuring progress.

3.1.1 Methodology Data Needs

The objective of the measurement methodology is to identify changes in toxic chemical use patterns, that is, changes in quantities of toxic chemical used, byproduct generated, shipped in product, released to the environment and transferred off-site. Toxic chemical quantities are available from Form S and Form R.

An additional objective is to measure changes in those quantities due to toxics use reduction, rather than changes in production. This requires a production "normalized" metric, i.e., one which accounts for changes in production level. Chemical quantities can be normalized by using either publicly available economic indicators, such as employment data, or data reported by facilities on the Form S or Form R. The following economic indicators were evaluated: employment data, alone or combined with worker productivity data, and value added data. Production data reported by specific facilities include the BRI and ERI from TURA Form S and the production ratio/activity index from TRI Form R.

In addition to these quantitative measures, qualitative metrics can be developed which provide an indication of *whether* TUR is occurring, but not necessarily an indication of *how much* TUR is occurring. Reported TUR or source reduction techniques used are examples of data elements which could be used to create qualitative metrics.

3.2 Data Availability

Methods for measuring TUR progress are limited primarily by the data that are available. This section evaluates ways in which the data availability affects the measurement methodology. Economic indicators for normalization are discussed first; this includes an examination of unresolved issues about whether those indicators are suitable proxies for production. An examination of the availability of TURA and TRI data follow. Key issues for TURA and TRI include the level at which data elements are reported and the years in which they were reportable.

3.2.1 Production Data For Normalized Measures

There are two ways to normalize TURA data, with data related to industry activity but not reported on the TURA or TRI forms and with TURA and TRI data reported by facilities on Forms S and R. Non-TURA economic indicators include: state employment data, industry productivity data, and value added by manufacture data. The following is an analysis of both the availability and suitability of each potential indicator for measuring TUR progress.

3.2.1.1 Employment and Productivity Data

Several studies have suggested that employment data could be used as a proxy for production level (Tellus Institute, 1991, Harriman, et al, 1991, Tellus Institute, 1995,). Harriman, et al suggested that total state-wide employment for the manufacturing sector, adjusted for productivity using national average output per manufacturing employee, could be used as a state-wide production indicator. Tellus proposed and tested the use of SIC level employment as a means to normalize SIC level trend analysis. The strength of employment information is its frequent and timely availability at several levels (state, SIC, etc) and its reliability as a data source. However, its weaknesses are many, due to several underlying assumptions. Use of employment as a proxy for production makes the following assumptions:

1) Employment at TURA reporting facilities parallels that at all facilities. - Employment data include all facilities, whereas chemical data are only for large quantity toxics users (LQTUs) that trip the reporting thresholds.

2) Employment numbers respond quickly to changes in level of production. - It is likely that in the short term employment is less cyclical than production output. If business is slow, employers are often reluctant to dismiss trained employees right away. Conversely, if business picks up, employers will use overtime for a while rather than risk the addition of more employees right away.

3) Overall employment parallels that for production workers. - Data for production workers are available infrequently (U.S. Department of Commerce, 1990, Census of Manufactures); therefore data for total employment must be used. The number of non-production workers in areas such as sales and research and development is likely to be affected by business prospects for the future, rather than current production.

4) The change in worker productivity is negligible over the measurement period. - In fact, anecdotal information indicates that worker productivity has increased dramatically in some industries. This is supported by data published by the U.S. Bureau of Labor Statistics, which show a 37% increase in the output for manufacturing workers over 8 years. (Harriman, et al, 1991) Unfortunately, productivity information is available only for selected SIC's, and as a national average for all persons in manufacturing. For aggregate state-wide measurement of progress, it is possible to adjust employment by using the national average change in output (productivity) for all manufacturing employees. This makes the assumption that Massachusetts industries parallel the national average in terms of the mix of manufacturing and their change in productivity.

Given the error inherent in these assumptions, it was decided not to pursue normalization based on employment, either at the SIC or the state-wide level.

3.2.1.2 Value Added Data

At 5 year intervals, and with a 3 year lag time, the Bureau of the Census publishes the *Census of Manufactures* (U.S. Department of Commerce, 1990). 'Value added by manufacture' economic data are provided at 2-,3-, and 4-digit SIC levels. Value added avoids the duplication in value of shipments or gross sales that results from the inclusion of products or materials produced by others. While it is a good estimate of the dollar value of manufactured goods, dollar values are influenced by other factors, such as the cost of labor and profit margins. In addition, depreciation allowances are included for capital equipment, which reflects past capital investment rather than current production. Because it is a less than ideal proxy for production and infrequently available, value added was not considered in this study.

3.2.1.3 TURA and TRI Production Data

Because of the problems with publicly available economic indicators, this study examined TURA and TRI data elements that can be used to normalize TURA data, specifically:

- the byproduct reduction index (BRI) reported on the Form S and
- the production ratio (PR) reported on the Form R.

These elements provide an indication of the change in production specific to each facility's use of a toxic chemical. The BRI is a production normalized byproduct reduction index that incorporates changes in production. The production ratio can be used for estimating expected trends in use, byproduct and emissions. This estimate can then be compared to the actual trends calculated.

These types of facility and process specific indicators of production are the most accurate means for normalizing, *for the LQTU facilities for whom data are available*. However, they are not necessarily a good proxy for *overall state-wide production*. Therefore, certain TUR activities, principally those which incorporate TUR into the initial design phase, will not be reflected. For example, new, cleaner production facilities which start up, or new product lines where TUR has been incorporated into the design process, will never report under TURA. A state-wide economic indicator would capture this expanded, cleaner manufacturing base, where production ratios for individual reporting facilities and production units will not.

3.2.2 TURA Data

The Massachusetts TURA data are reported by facilities on Form S; a copy is included in Appendix A. The data are stored within DEP's Facility Master File (FMF), an integrated database that holds facility data from all DEP programs. It is accessible to DEP personnel via a set of standardized reports or by viewing individual records on a computer screen. While this system maintains the accuracy of output by using only standardized reports, it limits the ability to manipulate and analyze the data. It also does not allow non-DEP personnel access to the data for analysis. DEP does have the ability to create "extract files" from the FMF. The extract files are PC-based text files of the principal data fields relating to TURA. This information can then be loaded into and manipulated by a PC-based database.[1] While this affords flexibility, the downloading process also introduces a source of error.

The data fields viewed as most likely to contribute to the measurement of state-wide progress were:

- chemical use, byproduct, and shipped quantities,
- TRI releases and transfers (included in the TURA database extract files)
- byproduct and emissions reduction indices (BRIs and ERIs),
- TUR technique codes (as qualitative measures), and
- production unit SIC codes.

The total quantities reported would provide a gross measure of toxics use and byproduct in Massachusetts. The BRIs and ERIs would be useful for normalizing and for indicating whether TUR activity was taking place. TUR technique codes would also be indicators of TUR activity. The SIC codes would be used to show how different industries were progressing.

The content and format of the TURA Form S on which facilities report TURA data was specifically defined by the TURA legislation. There are three levels of information required: chemical specific, production unit specific, and information about the use of listed chemicals in individual production units. The format of these sections of the Form S are described briefly below.

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[1]It should be noted that the data which are claimed as trade secret under TURA are not included in the extract files and so are not available for analysis by anyone outside of DEP. Aggregate quantities were provided by DEP so that trade secret data could be included in the most general state-wide measures. Unless otherwise noted, none of the results in this study include trade secret quantities.

3.2.2.1 Chemical Quantity Data

For each chemical, TURA specified that facilities report on the total amount of a toxic chemical used at the facility including the amounts manufactured, processed, or otherwise used. The facility also has to report on the amount generated as byproduct and shipped in or as product. The law very specifically stated that this information would be collected as an aggregated sum--for each chemical there would be one total number reported for each of the five quantities for the entire facility.

3.2.2.2 Production Unit Data

Facilities must divide their operations involving toxic chemicals into production units. A production unit is a process or combination of processes used to produce a product or family of products. A facility may define one or many different production units depending on what the facility decides will best describe its operations. For each production unit, a facility is required to describe the product, the general process used in the production unit, and the SIC codes that best describe the product made in the production unit. This information is provided once for each production unit although several different chemicals may be used in each production unit. As a facility and its products change, its production units may also change. Facilities are instructed by DEP not to redefine or reuse production unit numbers. When a production unit is no longer used or no longer uses reportable chemicals, its production unit number is retired. When new product lines are started up they are given new numbers.

3.2.2.3 Chemical Use in Specific Production Units

For every production unit in which a listed chemical is used, the facility is required to determine a base year from which progress will be measured, how much byproduct (BRI) and emissions (ERI) have changed since that base year, a code for the amount of chemical used in the production unit, and a code for the TUR techniques applied to the production unit. The codes for the amount used are specified in the legislation as:

- A (less than 5,000 lbs),
- B (5,000 to 9,999 lbs), and
- C (10,000 lbs or more).

The progress in reducing byproduct is reported as a byproduct reduction index (BRI). This is a production unit-specific calculation of reduction in chemical byproduct per unit of product. It is measured from a facility-defined base year to the current year. As such, it is already normalized for level of production. The BRI is calculated as follows:

$$BRI = 100\ \frac{A-B}{A} \tag{3.1}$$

where

A = (byproduct in base year) / (number of units of product produced in base year)
B = (byproduct in reporting year) / (number of units of product produced in reporting year)

The emission reduction index (ERI) is similar but measures changes in the amount of emissions generated per unit of product produced.

A positive BRI or ERI indicates that the amount of byproduct or emissions generated per unit of product has gone down. A negative BRI or ERI indicates an increase in byproduct or emissions per unit of product. The BRI can be as large as +100, indicating the elimination of all byproduct while still producing product in the production unit. It can also be highly negative (e.g., -1000), as might happen when a bath is dumped infrequently[2]. This type of tracking and calculation at the production unit level has the potential to provide the most accurate measure of TUR for reporting facilities.

TUR technique codes are reported if the BRI increased by 5% or more relative to the previous year. The TUR techniques to be reported are also specified in the legislation and are included with the Form S in Appendix A.

3.2.3 TRI Data

Unlike the TURA data which are reported at different levels, the TRI data are collected only at one level--total quantities for the listed chemical for the entire facility. Facilities report the information on the Federal Form R, both to the US EPA and to DEP. A copy of the Form R is included in Appendix D.

Much of the Form R information is stored in the FMF along with the Form S information. Some, but not all, of that information is downloaded into the extract files. In addition, for facilities that submit a Form R to the US EPA, TRI data is available on CD-ROM (US EPA, June 1995) as well

[2] If the bath containing a toxic chemical was not dumped during the base year, every reporting year after that in which it was dumped would show a large increase in byproduct per unit of product.

as on-line, for reporting years 1987 to 1993. By matching DEP facility names and addresses with those of TRI facilities, data from all sources can be combined and checked. For this project, some TRI data which were not available in the extract files were obtained from CD-ROM.

The releases and transfers reported on Form R are broken down into categories including:

- releases to different environmental media (fugitive and point source air releases, releases to land, releases to water, underground injection, land treatment, land disposal, and surface impoundments),
- transfers to publicly owned sewage treatment utilities (POTWs), and
- transfers to other off-site locations.

Since the amount of releases reported are often quite small, for this study releases to all environmental media were combined into one category. The quantities used from the Form R are: total releases, POTW transfers, and transfers to off-site. In some cases, these quantities were combined into a general 'TRI Releases and Transfers' quantity. In other cases the three categories were analyzed separately.

In addition to the quantities of releases and transfers, the Form R production ratio or activity index (PR) was used. This value represents the level of production at a facility in the reporting year, compared with the previous year. It is reported separately for each chemical and is defined as:

$$PR = \frac{Production(year2)}{Production(year1)} \tag{3.2}$$

When the production increases, the production ratio is greater than 1. When production decreases, the production ratio is less than 1. For example, a production ratio of 1.2 indicates a 20 percent increase in production. A production ratio of 2.0 indicates a 100 percent increase in production or double the amount of production over the previous year.

The EPA instructs facilities to calculate an 'activity ratio' instead of a production ratio when activities other than production are the primary influence on chemical usage. For example, the number of color changes at a printing facility may influence the cleaning needs more than the volume of printing produced, so an activity index based on the number of color changes can be used. The production ratio or activity index can be used to normalize the TURA and TRI data by factoring out changes in chemical use and byproduct generation related to changes in production level.

There has been some debate as to the accuracy of the production ratios. A 1994 U.S. General Accounting Office (GAO) report indicated that few manufacturers have the sophisticated data systems in place to provide reliable estimates of production or the waste related to specific production activities (US GAO, 1994). However, informal discussions with Massachusetts TURA filers have indicated that they have a high degree of confidence in the TRI production ratio, primarily because it is based on their unit of product data which are tracked for TURA reporting. EPA allows a wide latitude for estimating the facility-wide, chemical-specific production ratio. While they encourage calculations such as production ratio based on a weighted average unit of product, facilities may use a broad estimate instead. Massachusetts filers, however, indicated that they would be likely to use a weighted average of their more accurate production unit-based unit of product calculations to produce a facility-wide production ratio.

For this study, the TRI production ratios were available for 1991, 1992 and 1993, for all chemicals which were reported by each facility in the previous year. While there were a variety of inconsistencies in the reporting (see Chapter 4), the production ratios are available on a broad basis, in a timely manner, and are specific to the facilities under consideration. For these reasons, it was decided to pursue data normalization using the TRI production ratio.

Another TRI data element used was the facility-wide Standard Industrial Classification (SIC). These were used in conjunction with the SIC codes reported under TURA (at the production unit level) to create a facility-level SIC code for this study.

3.3 Data Useability

Because any methodology is only as good as the data upon which it relies, an important phase of the project was a review of the TURA data to determine their utility for measuring progress. Two aspects of these data that can affect the results of any methodology are data quality and reporting requirements. Data quality is how accurately the data collected, stored, and reported, reflect what actually happened at a facility. Reporting requirements include both the TURA legislation and the resulting regulations that prescribe what data are collected and in what format.

3.3.1 Data Quality

The quality, or accuracy, of the TURA data is key to the accuracy of the TUR measurement methodology. The data quality is a result of how it is collected, stored, and retrieved from the data management system. In the case of the TURA data, Forms S and R are used to collect the data and the data are stored in and retrieved from a data management system operated by the DEP. There are several points at which problems can affect data accuracy and reliability: facility reporting accuracy, data entry accuracy, and the accuracy of system utilities that manipulate the data.

At the facility level there are a number of factors that could affect the accuracy of the data reported on the Forms S and R. These are:

- lack of accurate measurement and/or reliance on inaccurate estimates,
- misunderstanding of reporting requirements, and
- clerical/mathematical errors in filling out the form.

Inaccurate reporting by the facility is difficult to detect and correct, except by direct, in-depth inspection of the facility. Although there are some general data quality checks that can be done on the reported data -- for example, ensuring that no BRIs greater than 100 are reported -- many reporting errors could go unnoticed.

At the DEP level, there are two ways in which errors can be introduced:

- when the data are entered into the system and
- when report or extract programs take data out of the system.

At the data entry point, errors can be the result of clerical mistakes transcribing the reports or lack of clear directions on what and how to enter the data. At the point data are extracted from the system for analysis, either in the form of reports or extract files, errors can be due to inaccurately programmed or inadequately documented reports and extract programs.

Because data quality can be affected at two levels, the analysis of data quality was done both at the facility level and at the agency level. A detailed facility level analysis, called the Facility Reality Check, was led by OTA. TURI researchers generated detailed reports for selected facilities based on the data in the extract files. The OTA researchers reviewed the reports and then visited eleven facilities where they met with facility personnel to discuss the reports and the reporting process. The objective of this part of the Reality Check was to determine what errors had occurred, what caused them, and how they could be prevented in the future. The Facility Reality Check is described in detail in Chapter 5.

The agency level data quality analysis, along with the documentation of obvious facility level reporting errors, was called the Data Consistency Check. This was a collaborative effort between TURI and DEP. TURI researchers used DEP-provided extract files to create custom reports for checking data consistency. These reports augmented DEP's existing "Data Exception" reports, which are run during the Quality Assurance/Quality Control (QA/QC) process by DEP prior to the release of the TURA data. The TURI reports were compared to DEP-provided reports and, in some cases, to the Forms S and R submitted by facilities. When problems were identified, DEP staff helped determine their source and determined the best method to fix the problem. The Data Consistency Check is described in detail in Chapter 4.

3.3.2 Changes in What is Reported

Regardless of what data elements are found in the reporting forms, the data that are actually available for analysis depend on what chemicals and industries are required to report and changes in a facility's status and use of a toxic chemical. The methodology needs to address these inconsistencies in the data.

3.3.2.1 Changes in Reporting Universes

Reporting under TURA was phased in over a four year period. Reporting was required for the majority of industries and chemicals in 1990 and smaller groups of industries and chemicals were added each year from 1991 to 1993. As a result, data for most, but not all, reporters is available beginning in 1990. Data for other reporters became available in 1991 through 1993 as depicted in Figure 3-1.However, the TURA goal of 50% byproduct reduction is set specifically as a measure of progress from 1987 to 1997. Since TURA data are not available for the years 1987 to 1989 and not all industries and chemicals were reported in 1990 through 1992, it is not possible for the existing data to measure progress from 1987. Efforts to estimate what would have been reported in 1987 had all industries and chemicals been required to report then are described in Chapter 6, *Establishing a 1987 Baseline*. In the absence of those estimates, the methodology developed measures progress for those subsets of the reported data for which data are available.

In the future, the chemicals and industries subject to reporting will continue to change as additional industries are added and chemicals are added or delisted. These changes in the reportable chemicals and industries cause changes in the quantities reported that are unrelated to economic or TUR activity. The methodology needs to account for these changes when measuring progress.

3.3.2.2 Changes in Facility Status

In addition to whether an industry or chemical is reportable in a given year, there are several other factors that determine if a particular facility is required to report on a particular chemical and whether those data are available for analysis. These include:

- chemical threshold - if the facility's use of a chemical is below the threshold, the facility is not required to report that chemical,
- employment threshold - if the number of employees is below the threshold, the facility is not required to report any chemicals, and
- trade secret - if a facility declares that use information is confidential, the facility reports the information but it is not made available for analysis to anyone other than a few select DEP employees.

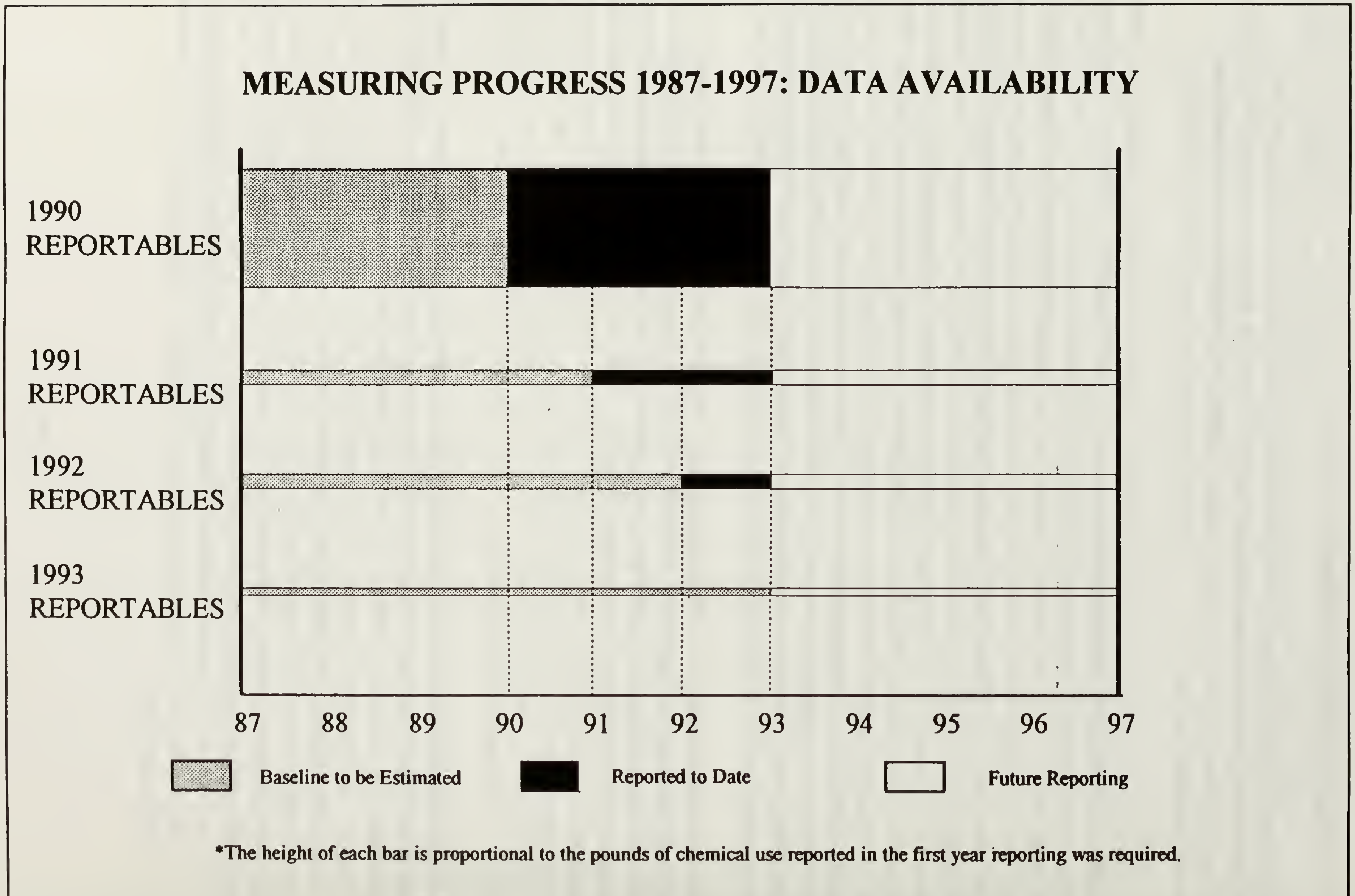
MEASURING PROGRESS 1987-1997: DATA AVAILABILITY
1990 REPORTABLES
1991 REPORTABLES
1992 REPORTABLES
1993 REPORTABLES
87
88
89
90
91
92
93
94
95
96
97
Baseline to be Estimated
Reported to Date
Future Reporting
*The height of each bar is proportional to the pounds of chemical use reported in the first year reporting was required.

Figure: 3-1

The methodology needs to account for the effect of these inconsistencies that result from these factors regarding the data available for analysis.

3.3.2.3 Variations in Production Unit Base Years

Facilities are required to select a base year against which each year's TUR achievements are measured. The base year for each production unit-chemical combination varies depending on the data available to the facility for the year reporting was first required and subsequent changes in the production unit. Since each BRI may measure progress from a different base year, the methodology needs to account for the varying base years when the BRIs are aggregated.

3.3.3 Inconsistent Level Used to Report Information

The most significant problem with using the TURA data to measure progress is that information is reported at different levels that can not be reconciled. As described in sections 3.2.1 and 3.2.2, facilities use Forms S and R to report information about total quantities of a listed chemical used and released for the entire facility. The production ratio and chemical quantities are reported at the facility level while BRIs, ERIs, SIC codes, and TUR codes are reported at the individual production unit level. This is described in more detail, with examples, in Appendix H. However, the result is that it generally is not possible to use the BRI, ERI, and TUR codes to measure overall TUR progress for a chemical, nor can the SIC codes, as reported, accurately show chemical use by industry.

3.3.3.1 Using BRIs to Measure Progress

If a chemical is used in multiple production units, there is no way to tell, given the existing data structure, which production unit had the most impact on changes in chemical use. However, for those chemicals that are used in only one production unit at a particular facility, the BRI for the production unit is, in effect, the BRI for the chemical at the entire facility. If the chemical is used only in that production unit at that facility for several consecutive years, the BRI can be used to show facility-wide progress for that chemical. If enough facilities report only one production unit per chemical, their aggregated BRIs could be used as a measure of the statewide progress. The methodology developed in this study includes a measure of progress for these types of chemical-production unit combinations.

Ideally, the Massachusetts TUR measurement methodology would include an aggregated BRI metric for all facilities. There are several ways that this could be accomplished, all of which require additional data to be reported. One option would be for facilities to report a facility-wide BRI, which would be a weighted average based on each production unit's use relative to the total.

In addition to a BRI, a measure of facility-wide use reduction normalized for production level (e.g., Use Reduction Index - URI or Input Reduction Index - IRI) and an ERI could be reported. This would preserve the separation between a facility's production unit information and their chemical quantities. The facility indices could then be aggregated to calculate state-wide normalized reduction indices. Other alternatives for aggregating production unit indices would be for facilities to provide the unit of product quantities or to report chemical quantities at the production unit level.

3.3.3.2 Facility Level versus Production Unit Level SIC Codes

Form R requires that facilities report a primary SIC code related to the activities at the facility. TRI use and activity information can then be summarized using the primary SIC code. Form S, on the other hand, requires that a primary SIC code be reported at the production unit level. As a result, a chemical may be reported under several different "primary" SIC codes, one for each production unit. This provides a more accurate picture of the types of production units associated with toxic chemical use. However, because the SIC code is not tied to a particular quantity of chemical, TUR progress cannot be measured by industry. The use for each production unit is only given as a range and the majority of production units are in the 'C' range, greater than 10,000 pounds. If chemical quantity is aggregated by production unit SIC code, the quantity can be counted multiple times, greatly overstating the actual quantities. (See Appendix F for a more detailed description of this problem.) The Data Consistency Check described in Chapter 4 analyzed the extent to which quantities were over-counted when totaling quantities by production unit SIC codes. The methodology takes this issue into account when measuring progress by industry by creating a facility-wide SIC code for each facility, and by analyzing broad SIC groups, rather than individual 4-digit SIC categories.

3.3.4 Sensitivity of BRI to Non-TUR factors

The BRI has a narrow focus of one chemical-one production unit and it depends on one year's quantities. As a result, it is extremely sensitive to unusual occurrences unrelated to TUR factors. Examples of this include the following:

- If a chemical bath is dumped every 18 months, a company could go from nearly zero byproduct in one year, to an extremely large byproduct in the next year, all with no changes in production.
- If the quantity of byproduct generated in one year is small, for example 20 pounds, the next year the byproduct could easily be either 10 or 30 lb with essentially the same practices. Although the actual quantity change is not large, the resulting percent change is quite dramatic.

- Some production units have varying production rates, e.g., batch processes or a production unit that is being shut down. The change in the number of products produced can have a significant effect on the BRI unrelated to TUR.

In order for the BRI to be useful for measuring progress, the effect of these issues on the results must be minimal or the methodology needs to be able to identify large changes, either actual or relative, that are due to non-TUR factors. The Facility Reality Check, described in Chapter 5, describes what was learned about the BRI sensitivity to non-TUR factors at eleven different facilities.

3.4 Data Overview Summary

The methodology is largely defined by the data available. Toxic chemical use, byproduct and shipped data provided under TURA allow the development of a methodology to effectively measure TUR progress. Additional information available in TURA and TRI databases supplement these TURA quantities, allowing for a broad-based methodology, consisting of multiple quantitative and qualitative metrics.

The primary limitation of the data is the overall lack of consistency in reporting. This includes inconsistencies in the level at which data is reported (production unit vs. facility) and changes in reporting requirements from year to year. The methodology must be designed to accommodate these inconsistencies.

4 DATA CONSISTENCY CHECK

KEY POINTS

- The data consistency check assessed problems with the TURA reporting practices, data quality, FMF system utilities, and extract procedures that affect the ability to use the data to measure TUR progress. The complexity of the TURA data represents a significant data management challenge.
- TURI and DEP systematically identified, reviewed and addressed TURA data quality and data management issues. Issues which could not be addressed immediately have been catalogued.
- Inconsistent reporting methods cause difficulty in using a variety of information, particularly the BRI and other production unit-level data, to measure TUR progress.
- At the facility level, inconsistencies are related to changing reporting requirements, trade secret claims, metal bender exemptions, wastewater treatment chemicals, and facilities dropping below or rising above reporting thresholds.
- At the production unit level, inconsistencies are related to production unit numbering, changing base years, and SIC codes.
- FMF system problems include allowing 'duplicate' records to be entered and not allowing erroneous records to be deleted.
- The methodology can be designed to accommodate some of these issues, others require data input corrections, modification of the FMF system or extract procedures, or further reporter training.
- These data problems cause suspect measurement results for subsets of data, particularly for specific industries, facilities or chemicals, but do not appear to have a significant effect on the overall state-wide measurement of progress.

4.1 Introduction

The purpose of the Data Consistency Check portion of the PPIS project was to determine what issues existed with the TURA data that would impact the effectiveness of the methodology for measuring TUR progress in Massachusetts. The Data Consistency Check project was a collaborative effort between the DEP staff and TURI researchers which began in the Spring of 1994, although the majority of the work took place between October 1994 and August 1995. The project was initially begun to provide some confidence in the data being used for two of the reports mentioned in Chapter 2 (Tellus Institute's *Taking Stock* report and TURI's *Second Report on Further Chemical Restrictions* report). The areas of review included:

- reporting practices and procedures,
- system utilities used to enter, report on, and extract data from the system, and
- data quality.

This chapter describes the methodology used for identifying data issues, the issues found, the status and schedule for resolving the issues, and a summary of the effect of the unresolved issues on the TUR measurement methodology.

4.2 Methodology for Identifying Data Issues

The steps described below were used to analyze TURA data extract files (ASCII text files) and reports. At each step, the reports and files were examined for problems in the areas of documentation, record format, and record content.

1) The compressed extract files were expanded and loaded into a PC-based database (Paradox™). The file structure of the PC database was kept as close as possible to the structure of the extract files to minimize conversion errors.

2) Programs were developed and run to test the internal consistency of the extract data. The consistency check programs were designed to check that individual facility chemical records contained a complete set of information and that the data "made sense" at a basic level.

3) Data in the extract files for selected facilities were compared to the Forms S and R on file at the DEP office.[1]

4) Data in the PC system were compared to two standard DEP reports--a listing of quantities reported by every facility sorted by town (Report TUR17) and a listing of quantities reported by every facility sorted by SIC code (Report TUR21_2).

5) Programs were run that tested the methodology and the methodology universes to see if there were any noticeable anomalies in the data. The anomalies were then reviewed to determine the cause.

At each of these steps, potential problems were identified and reviewed by TURI and DEP to determine the cause and the best solution. Some of the problems that were found have been corrected. Other problems, many of which require extensive programming work, are still waiting

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[1]A facility is required to submit a Form S and R for every listed chemical, a total of approximately 11 pages for each chemical for each year it is reported. The file for a company that reports on three chemicals each year (the average number reported) contains over 120 pages. Files of companies that reports on 10 chemicals each year could be several inches thick. Because comparing the actual report submitted to the data in the extract files is a time consuming process, individual facility chemical reports were only checked when a potential problem was identified. Once a facility's file had been pulled because of one identified problem, all the data elements were reviewed for accuracy.

to be resolved and are described in the next section. Appendix H contains a brief list of all the problems found and the current status.

4.3 Problems Identified

TURA data issues can be categorized by where the problems originated and by the effect of the problem on the methodology for measuring TUR progress. In terms of where problems originated, the sources fell into one of three categories:

- Reporting practices and procedures - this category included problems at the facility, agency, and legislative levels. At the facility level, problems occurred because of misunderstanding or misinterpretation of the reporting regulations. At the agency level, problems occurred because of the way in which facilities were instructed to report or the procedures for entering the data. At the TURA level, some problems are inherent in the way the legislation or regulations were written.

- System utilities - this category included errors or inconsistencies in the programs used to enter the data into the FMF system, the programs that create reports from the FMF system, and the programs that create the extract files.

- Data quality - this category included problems where a number was either written down incorrectly on the form by the facility or entered incorrectly into the FMF system.

This categorization of problem sources was useful in determining how best to resolve an issue. If the problem was due to facility error, it was added to a list of problems about which facilities were notified. If a problem was due to system utilities, reporting procedures, or agency data entry, DEP was responsible for addressing the problem. In response to some of the problems inherent in the TURA legislation and regulations, some recommendations for changes have been made in Chapter 9 and Appendix K.

The second method for categorizing TURA data issues is the effect of the problem on the methodology developed to measure TUR progress. Some problems could be corrected fairly easily or had minimal effect on the measurement results. Other problems require more time to resolve or would require changes to the legislation. In these cases, the methodology was modified to allow for these issues.

Invalid or unexpected data values were the result of both facility reporting errors and agency data entry errors. These problems were relatively easy to correct although they required more time for researching and for facilities to resubmit information. In general, the most easily corrected problems were those that were the result of errors in the DEP system utilities or incorrect data entry.

The rest of this section briefly describes the identified problems that have yet to be resolved and the steps that were taken to minimize their effect on the measurement methodology.

4.3.1 Incomplete Information

Because TURA data are reported at three different levels--chemical, production unit, and chemical-production unit--all three levels of information must be available for a complete data analysis. However, the data consistency check found a number of instances where records were missing information at one or two of the levels. These include:

- metal bender exemptions,
- wastewater treatment units, and
- data entry errors.

The majority of the problems are due to the first two items. A small number of the problems are due to data entry error.

4.3.1.1 Metal Bender Exemptions and Wastewater Treatment Units

There are two categories of reporters for which production unit level information is not required, i.e., metal benders and waste water treatment chemicals. A metal bender is a facility that only changes the shape of metal and has an aggressive recycling program in place. These facilities report the amount of metal processed but are not required to report production unit level information or submit a filing fee for the metal. Likewise, chemicals used in wastewater treatment are included in facility quantities, but no production unit level information is supposed to be provided.

In any year, between 25 and 100 million pounds of chemicals fall into the category of metal bender or waste water treatment and, as a result, do not have complete information. The metal bender quantities are concentrated in a small number of chemicals, primarily copper and copper compounds. The majority of copper use is in a small number of industries in the 2-digit SIC groups 33, 34, 36, and 38. For these metals and industries, the methodology can not reliably indicate TUR progress until complete information is available. The wastewater treatment chemicals include a number of acids and bases, although an exact list is not available. The wastewater treatment chemicals are spread widely throughout all the SIC groups and no particular industry is greatly affected by the loss of this information although the methodology cannot reliably be used to measure the progress of these chemicals. More detailed information on metal bender exemptions and waste water treatment chemicals is provided in Appendix F.

4.3.1.2 Data Entry Errors

Some of the incomplete records are due to data entry errors. For the years 1990 through 1992, between 20 and 25 records each year accounting for between 1.1 and 1.7 million pounds of total use are incomplete due to suspected data entry errors. For the year 1993, the number of incomplete records increased to 74 with a total use of 4.7 million pounds (approximately 0.5% of total use). Some of these may be related to the 'no delete' problems discussed in section 4.3.4.2. These problems are currently being researched and are expected to be corrected in the next data release.

In addition, during the first years of the exemption, there was substantial confusion around which metals were being claimed as exempt by each facility, and about how that information would be stored in the FMF. As a result, there are a number of metal benders for which some year's data had not yet been entered when the extract files for this project were run. These records account for between 3 and 17 million pounds each year.

4.3.2 Inconsistently Reported Information

For a number of reasons, data are not always reported or entered in a consistent fashion from one year to the next. In some cases this is due to facility or agency error but in other cases it is due to the way the TURA legislation was written. These are described below and include: changing facility ID numbers, names and locations, changing production unit numbers, and changing base years from which progress is measured.

4.3.2.1 Changing Facility ID Numbers

At the facility level there is a problem with a facility's data being entered under different ID numbers in different years. Although the total TURA quantities are not affected, there is no way to match the facility's data from one year to the next. The result is that the facility is not included in calculations of weighted average production ratio. In addition, if the facility uses a chemical in only one production unit over all reporting years, that production unit cannot be used in the 'single production unit per chemical' model of the methodology. There currently are six facilities that appear to fall into this category. These facilities account for between 3 and 4 million pounds of total use per year. These problems are being researched and are expected to be corrected by the next data release.

4.3.2.2 Trade Secret Chemical Records

This study was done with TURA data that is available to the general public. Under Massachusetts TURA, a facility is allowed to claim that the quantity or name of a chemical being used is confidential business or trade secret information. The facility's claim means that the information can not be divulged publicly without adversely affecting the company's business. In this case, the facility is required to file a complete TURA Form S and a "sanitized" Form S. The information is only accessible to specially designated employees at Massachusetts DEP. An inconsistency occurs when a facility reports a chemical in more than one year but does not claim it as trade secret in all years in which it is reported. In this case, the total amount of TURA chemicals available for analysis changes from one year to another.

Total Chemicals Reported Publicly in Some Years but Claimed Trade Secret in Other Years			
	90	91	92
Manufactured Amount	73,000	110,000	189,000
Processed Amount	4,368,469	18,608,777	3,319,967
Otherwise Used Amount	2,280,174	3,877,341	4,971,627
Total Use	6,721,643	22,596,118	8,480,594
Generated Byproduct Amt	2,341,191	3,967,731	5,136,950
Shipped in/as Prod Amt	4,265,552	18,538,995	3,292,835
TRI Releases&Transfers	642,327	529,166	1,141,637

Table 4-1

As can be seen from the table above, these records account for between 7 and 22 million pounds of reported total use (as much as 2% of all reported use) and 2 and 5 million pounds of byproducts (less than 4% of total byproduct) for the years 1990 to 1992. All the universes used to measure progress excluded all chemicals ever claimed trade secret.

Trade secret claims also result in an inconsistency between TURA extract files and publicly available TRI data. When a facility claims the TURA chemical quantities as trade secret there is no data provided for that particular chemical in the TURA extract files. However, release and transfer quantities for those same chemicals are included in the TRI database.

4.3.2.3 Inconsistent Production Unit Numbers

The reporting procedures instruct facilities to use the same numbers for a production unit from one year to the next and to retire any production units which are no longer appropriate. This is to allow comparison of TUR and BRIs in a production unit from year to year. However, due to facility and agency errors, the production unit numbers have not always been consistent. DEP's data input procedure is to contact facilities when there are questions about changes in production units. It is unclear whether this policy was followed consistently in the first few years of data input. Although a number of instances of inconsistent production units were found, determining the full extent of the problem would require a review of individual facility files.

The FMF system only has space to store one set of information for a production unit regardless of how many years it is reported. The information is updated each time new information is received. This can cause problems when a facility modifies a production unit. For example, a facility reports in one year that production unit number 2 is a degreasing unit in which Freon 113 was used. The degreasing unit is phased out and the facility mistakenly renumbers all production units to keep the numbers consecutive.[2] The following year, production unit 2 is reported as an acid etch bath that uses hydrochloric acid. If the data entry operator fails to correct or flag this discrepancy, the description of production unit 2 in the FMF system is changed to an acid bath and future reports show that both the Freon 113 and hydrochloric acid were used in an acid etch bath. This situation causes two different types of problems for the measurement methodology. First, chemical usage may not be attributed to the correct SIC code. Second, the fact that the data also show hydrochloric acid being used in production unit 3 in one year and production unit 2 the next year prevents it from fitting the 'single production unit per chemical' model.

4.3.2.4 Changing Facility Names and Locations

Another problem with TURA data is that name and address changes make it difficult to track facilities from one year to the next. There are two ways that this happens. First, personnel changes at a facility over the years leads to data being reported differently, either a different name is used or a different street or city address is given. For example, Ward Hill is a section of the city of Haverhill. In some years a facility's location is listed as Haverhill and in others it is listed as Ward Hill. This makes it difficult not only to track changes by area but it also makes it difficult to find facility files since they are filed according to city or town. There are also frequent name changes as companies are bought and sold. The second problem is that, as with the production unit level data, the FMF system has only one place to store facility level information. Each year, the address and contact information is changed to match the latest form. Historical records are kept of certain types of changes, but this information is not part of the extract files. In addition, the FMF data are also used by other offices within DEP, which can modify the name or address. The result is that the standardized report does not always match the data in the extract file. Because the methodology currently does not look at progress by location or facility name, this problem does not directly affect the results. However, it may be partly responsible for the problem with changing facility ID numbers described previously.

4.3.3 Invalid, Unexpected, or Undocumented Data Values

The TURI Data Consistency Check reports and the DEP Data Exception reports found a number of problems where data values were invalid, unexpected, or undocumented. An example of an invalid number is a BRI greater than 100, the highest possible value. An example of an unexpected value is a production ratio that is greater than 20. Although it is possible for a

[2] This is contrary to the DEP reporting instructions but not well understood by all facilities.

facility's production to increase 20-fold from one year to the next, it is not a common occurrence. An example of an undocumented value is a blank BRI (as opposed to a BRI equal to 0).

These included:

- BRI and ERI that were greater than 100,
- chemical records where the sum of reported byproduct and shipped quantities was significantly larger or smaller than the reported total use (amount manufactured, processed, and otherwise used) with no explanation,
- BRI or ERI much less than -100,
- chemicals with a production ratio less than 0, the lowest possible value,
- chemicals with a production ratio much greater than 10,
- chemicals with a production ratio much greater than 1 when use and byproduct did not change significantly from the prior year,
- chemicals with 0 production ratio when not the first year reporting,
- chemicals with blank production ratios, particularly when the base year is other than the current year,
- production units with a base year other than the current year with no BRI or ERI reported,
- facility names or city locations mismatches between the DEP standard reports and the data in the extract files,
- missing or extra facilities, and
- missing, extra, or invalid SIC codes.

These errors do not affect the overall measurement of TUR progress but can greatly affect measurement for an individual industry, industry group, chemical or group of chemicals, as well as the general ability to manipulate the data.

4.3.3.1 Duplicate Facilities

In some cases, facility information has been entered more than once under two different facility ID numbers. These records accounted for 27 million pounds of total use in 1991 and 1.4 million pounds in 1993, mostly in the processed category. These were excluded from the universes used to measure progress.

4.3.4 System Utilities

Several problems were found with the system utilities, the programs that enter and maintain the TURA data in the FMF files. Because the TURI researchers do not have direct access to the

FMF system, the exact nature of the problems could not be identified. This section describes the symptoms of the problems, which briefly are:

- duplicate key records allowed in the database,
- no delete function is available for records entered in error,
- non-reportable chemicals can be entered into the system, and
- data exist for years when not reportable.

The first two are the most significant and cause problems with the measurement methodology and are described in the next section in more detail.

The third and fourth are inconvenient but the few erroneous records are easily identified and can relatively easily be ignored. Non-reportable chemicals are chemicals that either a facility has reported erroneously although it is not on the list of reportable chemicals or have been incorrectly input into the system. The list of non-reportable chemicals in the system can be found in Appendix B.

4.3.4.1 Duplicate Key Records Allowed in Database

Duplicate key records are multiple records that cannot logically exist given the data structure. For example, in some cases the database would have two coversheet records for one facility for a given year even though only one coversheet can be submitted. In others, a facility would have two records for a single chemical for the same year with different quantities, even though only one Form S can be submitted for a chemical in any given year. In all cases of these records, the second record in the extract file was excluded from the study.

These records accounted for approximately 250 records in all the extract files combined, between 1.2 and 1.9 million pounds of total reported use per year, and between .9 and 1.2 million pounds of total reported byproduct per year. These quantities represent 0.1 percent of the total reported use and 1 percent of the total reported byproduct including trade secret quantities.

4.3.4.2 'No Delete' Records

The system utility program used to maintain the FMF system does not allow any chemical record to be deleted once it has been entered into the system. As a result, if a record has been entered in error, it remains forever in the system. Since data entry mistakes do occur on occasion, the DEP has developed a procedure for flagging erroneous records by setting quantities at the chemical level to 0, except for one quantity (the database system requires one non-zero quantity field). The one non-zero field is set to '1 lb'. Exactly which quantity is left as '1' depends on the person doing the correction.

There are approximately 195 of these records that cannot be deleted, called 'no delete' records. This is only an approximate number because the Duplicate Key records mentioned above may include 'no delete' records. In addition, of the 195 'no delete' records identified, 139 records have not been 'zeroed out' correctly and still contain values in the TRI releases and transfers fields or contain a number slightly larger than one in the five TURA fields.[3] Because the quantities in the TRI fields tend to be small, the TRI quantities do not effect the measurement methodology. However, because part of the methodology involves analyzing facilities that have reported consistently over several years, these records need to be excluded from the methodology universes. The procedure used for excluding these records from those universes involved examining the five TURA quantity fields and excluding any record where the total of all five TURA fields was less than 10 lb.

4.3.4.3 Report Missing Facilities

The TUR17 report does not always include all facilities that are in the extract files. There appear to be undocumented procedures in the report that exclude facilities that have been closed or that were entered into the database erroneously. This problem makes it difficult to compare the extract files to the FMF database but does not affect the methodology.

4.3.4.4 Extra SIC Codes in Report

The algorithm that FMF's TUR21_2 report uses to categorize chemical use by production unit SIC code, includes use in SIC codes in years in which a chemical was not used in a production unit. For example, a facility reports a production unit 2 with SIC code 3643 in 1990 and with SIC codes 3643 and 3483 in year 1991 through 1993. Toluene is used in production unit 2 only in 1990. In this case, the TUR21_2 report would include the Toluene quantities under both 3643 and 3483. This is inaccurate and increases the extent to which SIC code reporting of quantities overstates actually quantities. This error does not affect the methodology, only the results of the standardized DEP report.

4.4 Impact on Measurement of TUR Progress

The result of all the identified data issues is that use of the BRI and production unit information is disrupted by inconsistencies and errors, and so can not reliably be used in most cases for measuring TUR progress at the facility, industry, and state level. Therefore, the methodology was developed to utilize the more reliable data, and to account for inconsistencies where possible. Table 4-2 shows the quantities that are involved in issues that affect the overall measurement of progress. The second half of the table shows the quantities that are involved in measuring

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[3] manufactured, processed, otherwise used, byproduct generated, and shipped in or as product.

progress at the production unit level and therefore affect the use of BRIs, TUR codes, and SIC industry codes.

Impact of Data Issues and Incomplete Production Units

Total Use Affected by Data Issues (millions of pounds)				
	1990	1991	1992	1993
Metal Benders with Missing Data	14.7	3	5	17.3
Duplicate Facilities		27.4		1.4
Duplicate Key Records	1.3	1.4	2.6	1.9
Inconsistent Trade Secret	6.7	22.6	8.5	.1
Total Use Excluded	22.7	54.4	16.1	20.7
Total Use in Extract File	927.1	1012.9	1033.6	1015.0
Percent of Total Use Excluded	2.4	5.4	1.6	2

Total Use For Which Production Unit Information (BRI, TUR, SIC) is Not Available (millions of pounds)				
	1990	1991	1992	1993
Incomplete Records	23.3	5.8	11.4	54.7
Inconsistent Metal Bender	74.2	71.7	78.0	81.0
Facilities with Different ID	3.3	3.6	4	3.1
BRI or ERI > 100	19.5	-	-	-
BRI or ERI < -500	.1	6.4	21.3	24.9
No BRI but Base Year not Current Year	89	70	110	120
PR < 0	-	7.3	4.3	3.7
PR > 20	-	6.2	5.3	10.4
Total Use with Production Unit Data Unavailable	206.1	167.4	230.3	294.7
Total Use in Extract File	927.1	1012.9	1033.6	1015.0
Percent of Total Use with Production Unit Data Unavailable	22.2	16.5	22.3	29

Table 4-2

5 FACILITY REALITY CHECK

KEY POINTS

- A detailed review of eleven facilities was performed to check how well the TURA data reflect actual TUR progress at facilities. The facilities were selected to represent a broad cross-section of facilities and industries.
- Nearly all of the selected firms had made TUR related changes to their manufacturing processes.
- "Best practices" in materials accounting were identified. They include: computerized tracking of chemical use and byproduct information, actual measurement of use and byproduct quantities rather than relying on estimates, and periodic checking of estimates and assumptions with actual data. Facilities that used "best practice" techniques had more confidence in their TUR data.
- Does the BRI accurately reflect TUR? Not in all cases. Characteristics of "low confidence" BRI's included production units with batch processes, small quantities of byproduct, difficulty in selecting a correlated unit of product, and poor base year data. Characteristics of "high confidence" BRI's included production units using "best practices" materials accounting, continuous processes and chemicals otherwise used with integral or no recycling.
- One firm regularly uses a modified BRI as an environmental management tool. Another firm uses an Input Reduction Index (IRI) daily to track chemical use per unit of product.
- Facility Form S data from the FMF extract files were reviewed for obvious reporting errors. The facility reporting errors identified resulted in a 1.8% absolute error in combined total use, byproduct and shipped. Data entry errors resulted in an additional 0.06% absolute error in total chemical quantities. There was a higher error rate associated with production unit information.

5.1 Introduction

Massachusetts' Office of Technical Assistance (OTA) role in the evaluation of TUR progress was to perform a 'reality check' on data reported under TURA. The purpose of the check was to examine whether TURA information reflects actual TUR progress among a subset of case study firms.

To perform the 'reality check', OTA examined TURA reporting at 11 Massachusetts firms. Firms were chosen from industries representative of the types of industry most frequently reporting under the state Act -- namely chemicals, plastics, metal manufacturing and finishing, electronics, paper, coating, and textiles. The eleven firms included companies that manufacture, process, and otherwise use TURA listed substances. From a list of firms in each of these sectors, researchers selected firms as case study candidates based on four criteria:

- large quantity of chemical use,
- large number of reported chemicals,
- variation in the number of employees, and
- previous contact with the firm.

Researchers contacted potential participants and asked for their voluntary cooperation. Eleven firms ultimately were chosen for study. Table 5-1 presents data on these firms, including: the industry, operation SIC code(s), the number of employees, the number of production units, and the number chemicals reported in 1993.

The eleven case study firms represent a diverse set of manufacturing methods and approaches to TUR reporting. Case study firms varied in their

- use of chemicals with high vapor pressure (and hence difficult to measure fugitive emissions),
- use of chemicals used in water-based processes (and attendant difficulty measuring wastewater byproducts),
- use of chemicals converted and/or consumed during processing,
- reported amount of toxics use reduction,
- operation of job shops, semi-captive and captive operations,
- operation of batch, semi-batch, or continuous processes,
- operation of production units with integral recycling, and
- their use of consultants versus in-house planners to prepare annual TURA reports.

Table 5-1 Demographics of Firms Selected for Reality Check

Firm	Industry	SIC Code(s)	No. of Employees	No. of Prod. Units	# Chemicals Reported (93)
Textile Firm	Dyeing, Finishing, Coating	2299, 2269, 2262	350	2	12
Metal Finisher	Electroplating	3471	40	5	11
Paper Manufacturer	Paper	2261	150	1	9
Chemical Products Manufacturer	Coatings, Adhesives, Urethanes, Paint	2821, 2851, 2891, 2893, 2843, 2899,	170	8	17
Diversified Metal Manufacturer	Metal Cladding, Finishing, Electronics	3469, 3822, 3089, 3356, 3398, 3341, 3714, 3351, 3355, 3471, 3679, 3812, 3451, 3299	5,200	42	18
Coatings Manufacturer	Resins, Coatings	2851, 2891, 2893	100	3	21
Tape Manufacturer	Tape	2295, 2869, 2672, 2671,	160	4	2
Flexible Web Coater	Coated Paper And Film	2672	600	2	14
Plastics Manufacturer	Plastics	3087	120	1	6
Iron/Steel Foundry	Forging	3462, 3463, 3341	860	8	10
Leather Processor	Leather Products	3111	74	1	7

Given the main objective of this study -- namely to assess the extent to which publicly reported TURA data reflects progress at these 11 case study firms, researchers developed a series of interview questions. The questions were aimed at understanding how firms collected, stored, and analyzed data used to file their annual TUR reports with DEP. The questions, outlined in Figure 5-1, were posed to the person responsible for TURA reporting at each company. For small companies, this person often has several job responsibilities. In larger firms with dedicated environmental staff, the person charged with TURA compliance answered the research questions. Site visits and interviews at each firm lasted two to four hours. Following the visit, researchers received additional information via telephone and fax.

The following questions were asked of each case study firm. These questions were chosen to understand the linkage between TURA reporting data and reductions at each case study firm.

General Questions:
Describe the main TUR changes your firm has instituted since 1989.
Do you believe your firm's TURA reports reflect these changes? If not, why?

Materials Balance Data:
How do you do your material balances? Where is the data stored?
How do you estimate use, byproducts to each media, conversion, and shipped-in-product?
How has your procedure for putting together a material balance changed since 1987? Since 1990?

Production Unit Definition:
How did you define your production unit(s)?
Would you like to change your production unit definition(s)? If so, why?
Do the attributes of types of products produced in your production unit(s) change? If so, describe the magnitude and type of change(s)

Unit of Product:
How did you choose your UOP(s)?
Is the UOP(s) the same as the EPA Form R Production Ratio/Activity Index
Have you changed you UOP(s) since the base year? If so, why?
Would you like to change your UOP? Why?

Indices:
What confidence do you have that the BRI and ERI reflect the TUR (or lack there of) in each of your production units?
Do the TURA codes in this part of the form reflect the kinds of changes you have made to your production units?

TURA Planning:
In preparing your TURA plan, did you refine or make changes to the way you collect/report TURA data?
Was the TURA planning process helpful? If so, how was it helpful? If not, why?
How did you develop your 2 and 4 year TUR goals -- what assumptions did you make in the data to calculate these goals?

Substitution:
Have you made any TURA chemical substitutions since 1989?
If so, what chemical did you substitute? What was the substitute chemical?

Other Reporting Questions:
Has your past reporting made it simpler to answer this year's questions on process codes?
How have your data collection methods and systems changed since you first started collecting TURA data?
What confidence do you have in your baseline data versus the current year's data?
Did someone else prepare the Form R(s) and S(s) in previous years?
Have you filed any changes or amendments with DEP for a prior year's TURA filing?
Have you attended OTA/DEP seminars on TURA planning? When?

Figure 5-1 Research Questions

5.2 Findings

5.2.1 TUR Accomplishments

Nearly all of the firms interviewed in the study have made TUR changes to their manufacturing processes since 1989 (ten of eleven firms cited TUR accomplishments to researchers). While interviews with case study firms pointed to varying levels of TUR progress, all eleven firms were cognizant of the Commonwealth's new focus (as of 1989) on preventing pollution as toxics use reduction. Table 5-2 highlights a portion of the case study firm TUR accomplishments.

Table 5-2 Case Study Firm TUR Accomplishments

Firm (Industry)	TUR Accomplishments
Textile Firm	Modified coating equipment to run more water-based coatings (as opposed to solvent-based coatings). The company also eliminated acetic acid by switching to glycolic acid however the substitution pushed hydrochloric acid use over 10K lb. threshold (8K to 11K). The firm reduced chromium dye use by convincing customers to switch to non-chromium dye agents.
Metal Finishing	Improved control of additions and storage and handling procedures to reduce methanol use and byproducts.
Paper Manufacturer	Reduce use of sodium hydroxide by 45% per unit of product by improved operation and maintenance of process equipment.
Chemical Products Manufacturer	Market-driven substitution of water-based coatings for solvent-based coatings. The company has also reduced waste by increasing its use of waste-reducing piping, improved scheduling, and use of larger and/or dedicated tanks.
Diversified Metal Manufacturer	Firm has a broad-based, risk-based TUR program that includes phaseout of all chlor-organic compounds, ozone depleting substances, hydrochloric acid, cyanide, cadmium and ammonia. Firm has redesigned products, modified processes, and re-invented manufacturing operations to meet its aggressive TUR goals.
Coatings Manufacturer	Stopped using 1,1,1 trichloroethane as a coating component as a result of labeling law. The company has also reduced their use of lead chromate pigments.
Tape Manufacturer	Eliminated methyl ethyl ketone as a cleaning solvent, replacing it with a M-Pyrol-based cleaner. The company has switched to more water-based and higher solids adhesives.

Firm (Industry)	TUR Accomplishments
Flexible Web Coater	Eliminated the use of Michler's Ketone, methyl-isobutyl-ketone, and methoxyethanol as coating components. The company also minimizes the use of virgin solvent for wash-up and has been making a broad-based effort to evaluate and switch to aqueous-based coatings prior to 1989.
Plastics Manufacturer	Eliminated lead chromate, hexavalent chromium, and cadmium pigments in their product. The elimination of cadmium pigments allowed them to eliminate antimony and selenium as well They are still using chromium But at one time they were using chrome III and VI now they only process chrome III.
Iron/Steel Foundry	Replaced a glycol ether based cleaner with an aqueous cleaner and ultrasonic unit
Leather Processor	No TUR

With a broad array of TUR accomplishments in the study, researchers turned to examining how these firms measured their progress under the terms laid out in the state Toxics Use Reduction Act. In examining these measurement practices, researchers looked for 'Best Practice' measurement methods.

5.2.2 Materials Accounting Best Practices

Any evaluation of TUR progress tracking must examine the manner in which materials accounting data are collected. This portion of the report examines how the 11 case study firms collected their use, byproduct, and emissions data for TURA reporting.

Most firms (ten of eleven companies) in the study agreed that their materials accounting methods had improved since 1989. These improvements ranged from measurement of byproducts and emissions (as opposed to estimates), to better inventory control procedures, to employee training. The most prominent change, however, was the computerization of TURA data. Computerization included the use of batch processing software to better track production operations, use of spreadsheets and databases to determine and compare chemical use with reporting thresholds, and the incorporation of TURA data elements into production control data tracking systems.

5.2.2.1 Use Tracking

In order to examine reporting accuracy, investigators established a set of materials accounting 'best practices'. When employed, the practices produce materials accounting data that most accurately determines chemical use and byproduct generation. Best practice chemical use tracking includes:

1. combining purchasing, shipping, and inventory records to obtain an accounting version of materials use and cross checking the accounting information with physical inventory checks and production floor tracking to spot data inconsistencies,
2. determining which reportable chemicals were used at the facility for the reporting year from MSDS's,
3. tracking the formulas of intermediate and final products that contain reportable chemicals,
4. track chemical use on the production floor via batch tickets, material transfer records, and production logs to obtain a production version of materials use (as opposed to an accounting version of use), and
5. computerization of items 1-4 above.

Researchers examined the extent to which case study firms employed the 'best practices' outlined above. None of the case study firms employed all of the practices. However several firms employed some of the practices -- these firms had the most accurate data on which to examine chemical use. One example of such practice was the diversified metals manufacturer. The firm uses a 'Just in Time' inventory system and therefore carries little chemical inventory -- no more than two weeks worth at any one time. As a result each chemical is brought in specifically for each production unit -- therefore production-unit level chemical tracking is quite precise. A second firm (flexible web coater) also exemplified several best practice materials accounting techniques. The firm generates batch tickets for both product formulations as well as equipment cleaning. While companies employ batch tickets for products, only the flexible web coater used wash tickets -- enabling them to accurately track solvent usage in an ancillary operation. This method gives them a wealth of production unit level data that makes their reporting extremely meaningful.

While most firms in the study had a fairly good handle on facility-wide use data, few firms had accurate production unit level data tracking. This is due to the lack of a chemical chain-of-custody from the chemical store room to the production floor point-of-use. For example, the textile firm has difficulty tracking their processing chemicals. The firm has accurate measures of monthly chemical use for processed chemicals because they closely monitor their chemical inventory. Yet once the chemical moves onto the floor for use in a process, they lose track of it. The batch tickets that the firm uses for its products do not describe the chemicals used for each job. While implementing a system to track actual usage would be expensive, it would provide valuable business information in addition to good TURA data.

Table 5-3 delineates 'Best Practice' chemical use tracking among case study firms. One firm in the study, the flexible web coater, demonstrated the best use tracking. Because of its practices, it had the most accurate production-unit level use data of any case study firm. The numbers in column one of Table 5-3 pertain to the best practices outlined on the previous page.

Table 5-3 Best Practice Use Tracking

SCOPE *Best Practice Technique Number*	Activity	Best Practice	# Firms to which activity applies	# Case Study Firms demonstrating close match to Best Practice
FACILITY WIDE *1*	Inventory	physical inventory periodically checked against purchasing records;	11	6
2	MSDS Tracking	computerized	11	2
2	Calculating Thresholds	all MSDS's monitored for TURA chemicals	11	11
3	Formula Tracking	computerized	5	1
4	Otherwise use -- batch and equip. cleaning	batch tickets generated, actual use recorded	10	1
3	Chemical Adds	actual measures recorded	11	8
4	Recycling (hard piped)	track actual use/byproduct	4	1
PRODUCTION-UNIT LEVEL *1-4*	Production Unit Level Data - Use - Formula Tracking - Batch Tracking	computerized, daily tracking, measure chemical use instead of allocating or estimating	11	2

5.2.2.2 Byproduct Tracking

The second chief data element in a materials accounting format is byproduct measurement and estimation. Most firms determine their byproducts via engineering approximations such as emissions factors, filling loss rates, transfer loss rates, and chemical consumption estimates. Best Practice techniques to determine TURA byproducts include:

1. use of engineering factors as approximations;
2. periodic checking of engineering factors with actual testing to assess their accuracy;
3. actual byproduct-stream measurement; and
4. cross checking of byproduct data by performing analysis with use, conversion, and shipped-in-product information.

Best practice clearly would be to measure byproduct generation rather than using estimation methods. Few firms, however, measure byproducts on a continuous basis. Several firms periodically measure such factors whereas other firms make only estimates with little basis in actual testing. The researchers found that companies with comprehensive byproduct information had not collected it specifically for TURA but for other regulatory (Clean Air Act) or business purposes.

Two firms best exemplify 'Best Practice' byproduct tracking -- the flexible web coater and the diversified metal manufacturer. The flexible web coater collected extensive emission data as a result of requirements under the Clean Air Act. The data provide the coater with an accurate measure of byproduct generation at the production unit level. The diversified metals manufacturer employs engineering factors but performs testing to adjust these factors. For example the company tests its acid etch baths to understand the relationship between acid use, consumption, and byproducts in its etch processes. In another operation, the diversified metal manufacturer uses byproduct estimates for their plating chemicals, but cross checks these with RCRA waste data. This is precisely the type of check that make an estimate a much more reliable piece of data. Byproduct 'Best Practices' for the 11 case study firms are outlined in Table 5-4.

One major weaknesses researchers found in materials accounting methods was a lack of production unit level data. This information simply is not collected by most firms. Instead companies use estimates and assumptions about factors to determine byproducts. Few firms periodically check these assumptions with actual testing. For example, the textile company uses engineering factors to determine byproduct for processed chemicals. By assuming that a certain constant fraction of use becomes byproduct, the BRI does not give a meaningful indication of TUR progress -- for example changes that make the process more efficient will not show up in the BRI since the byproduct factor is held constant each year. Furthermore, the firm has no way of knowing whether one process creates significantly more waste than others and should be targeted for toxics use reduction efforts. The textile firm was not the only firm to adopt generalized estimates of byproducts from factors -- researchers consistently found this practice among case study firms.

A second weakness concerns how firms calculated amount of the toxic chemical shipped in product. In several instances, firms derived shipped-in-product figures by subtracting byproduct estimates from annual use. Thus the shipped in product numbers were no more accurate than the spurious byproduct estimates.

Byproduct tracking was most difficult for batch-production firms with broad product families -- such as the coatings manufacturer and chemical manufacturer. Each time a batch is run, a given volume of toxic material is used to clean the production vessel, pumps, and values. Such cleaning chemicals typically are reused several times and are often used as raw material in subsequent batches. With tens of batches of product run daily, these manufacturers find it difficult to track cleaning chemicals in any way other than by engineering estimates. Since the firms have little faith in their tracking data, the data are relatively meaningless for targeting TUR opportunities.

Researchers found variation in measurement for the same chemical used in the same or very similar processes at different firms. For example, the forging firm had a very accurate tracking system for acid usage in an etch operation. The company tests acid baths daily. Acid byproducts in the form of evaporation and carryover are also measured. Such tracking presents an accurate picture of acid use, consumption, and byproducts. Other firms in the study do no such testing, however. While their use data is accurate, consumption and byproduct (air emissions and carryover) figures are based upon best-guess estimates. It's important to note that the forging firm performs regular testing because its process is very sensitive to acid content -- not because the firm wants to collect more accurate TURA data.

Table 5-4 Byproduct Tracking Best Practices

Best Practice Technique Number	Activity	Best Practice	# Firms to Which Activity Applies	# Case Study Firms Demonstrating Close Match to Best Practice
1,2	Utilize engineering factors for byproduct calculations	check engineering factors with actual periodic testing	7	2
3	Production unit level data for byproduct generation	measure byproduct instead of estimating amounts	all	none
3	Chemical batch dumps	testing prior to dumping	9	2
3	Misc. cleaning, chemicals reused not hardpiped	tracking each use -- recording the data	10	2
4	Metal alloys byproduct tracking	shipping and purchase records, measuring waste tonnage	4	2

5.2.2.3 Production Unit Definition

The review of materials accounting practices led to an examination of how firms defined their production units. Three firms defined their entire facility as one production unit while others divided the facility into multiple production units. The advantage to broadly classifying the facility into one or two production units is that such classification greatly simplifies that level of data detail needed for TURA reporting. Yet this practice generally defeats the purpose of collecting production unit data to examine the chemical use and losses of each process. For example, in the case where a chemical is used in several production processes in a plant, dividing the plant into multiple production units will help to identify gains or losses in process efficiency.

There are cases in which it makes sense to identify the facility as a single production unit. The best case for such a classification among the 11 case study firms was the paper mill. The mill runs a single, continuous process that produces a single product. Thus a single production unit is the most logical (and simplest) way to track progress.

When firms designated greater numbers of production units, they retained the ability to track TUR progress more closely. But more production units translate into more data collection -- such as production-level use, byproduct, unit of product, and emissions tracking. Without exception, the eleven case study firms designated their production units based upon data availability. Since existing data drove production unit definitions (as opposed to TURA reporting), existing data influence how accurately a firm would track its TUR progress. Table 5-5 summarizes how case study firms defined their production units.

Best practice production-unit definition is exemplified by the diversified metals manufacturer. The firm designated 42 production units using a team process involving plant-wide personnel and facilitated by the firm's environmental manager. The production units correspond with cost tracking, production control, and management responsibility. However these production units were designed to fit an existing data collection and management reporting structure and were not invented for the purposes of TURA. The firm's production control system tracks a surprisingly high-level of materials accounting data in each of the 42 production units, producing reliable TUR progress data.

Other case study firms were not so meticulous in their reporting. Several firms grouped multiple processes into highly aggregated production units. The coatings manufacturer's use of highly aggregated units made unit-of-product tracking difficult and lacked finely divided data that could aid in identifying opportunities for TUR. Other firms designated production units but failed to measure production-unit level data. For example, the forging company designated eight different production units but does not record production-unit level data. This company reports no BRI/ERI because they have done no TUR -- thus any reported numbers would be due to random noise as opposed to any real reductions (or increases). At the same time this practice prevents the firm from using production units for unit operation analysis. While the firm has taken the time to analyze their facility and divide it into multiple production units, they do not put these production units to any productive use.

Table 5-5 Case Study Production Unit Definitions

Firm	No. Prod. Units	Basis for Production Unit Definition	#93 Chem
Coatings Manufacturer	3	Two main product categories, acrylic and non-acrylic based products, and third PU is solvent washing and distillation step	21
Tape Manufacturer	4	Various coating lines	2
Flexible Web Coater	2	Two main substrates coated, paper and film	14
Plastics Manufact.	1	Facility wide production unit	6
Iron/Steel Forging	8	Combination of differing materials forged and processes used such as metal cutting, acid treatments	12
Leather	8	Only one chemical process, occurring within an enclosed drum	7
Textiles	8	PU #2 fabric preparation, PU#1 rotary screen printing and dyeing of fabrics	12
Metal Finisher	5	Plating lines plus wastewater treatment and one PU for the entire facility	11

Firm	No. Prod. Units	Basis for Production Unit Definition	#93 Chem
Paper Mill	1	Entire facility	9
Chemical Products	8	Product lines and families of product lines and one for the still	17
Diversified Metals	42	Chief production departments	18

Several of the case study firms have taken a second look at the way they have designated their production units and modified their definitions to better fit their manufacturing activities. Other firms expressed interest in such redefinition. For example, the tape manufacturer would like to revisit the way it has designated production units and possibly redefine them. This stems in part from the fact that the current environmental manager was not in that position during the base reporting year. They have designated their solvent reclamation system as two additional production units on each of the main coating lines, but have incorrectly recorded BRI information for these production units.

5.2.2.4 Determining and Tracking the UOP

This section examines normalizing factors used in different industry sectors. An accurate unit of product allows a firm to measure TUR progress while correcting for changes in business activity. The variety of units of product represented here is an indication of the choices available to firms making this decision. Generally speaking, non-physical measures are less accurate than physical measures of production. The more closely the unit of product is related to the chemical usage, the more accurate the measure.

All firms in the study chose their unit of product from available data (as opposed to collecting new data specifically for this purpose). But relatively few firms believed that their normalizing factors did an excellent job of adjusting byproduct generation to the firm's level of production. For one firm in the study (paper mill), choosing the unit-of-product was relatively straight forward. The firm produces one product in one continuous process and the causal link between production and chemical use/byproduct generation is obvious. However the relative ease of the paper mill's unit-of-product choice was the exception to the rule. More often firms were faced with more complex product mixes, uncertain relationships between production and use/byproducts, and a paucity of easily-available production data. Nevertheless, several firms overcame such obstacles to produce rather accurate normalization factors. For example, the flexible web coater uses square yards coated as their unit of product. Their coating machines have various capacities ranging from single to multiple coating heads. Depending on the product, the machine may coat one or both sides of the substrate. Rather than just using production numbers of square yards coated, they have developed a database that tracks the number of times each square yard is coated and with what product. This database was originally developed for tracking VOC emissions but provides excellent information for TURA purposes as well.

Other firms were unable to overcome their unit-of-product tracking dilemma. For example, the leather finisher uses surface area (of the tanned hides) as their unit of product. Surface area is an industry standard -- the hides are bought and sold using this measure. Yet problems occur when different types of hides need different chemical treatments/dyes. The firm does not track chemical treatment by hide type. Thus their surface area measure does not capture chemical usage as accurately as it could. The forging company also felt their unit-of-product was less than perfect. The firm uses weight as a unit of product. However the firm would prefer to use surface area as the unit of product for the acids used in a chemical milling process. Because the chemical baths are used to etch the metal surface, surface area would produce more accurate results than weight. Yet the company has no other use for the surface area information -- making it difficult for the environmental manager to justify tracking production in this manner. Thus the manager continues to track production through the acid milling process based on the weight of product processed.

The chemical products manufacturer uses pounds handled and blended in each area for its unit of product. The coatings manufacturer uses gallons of product sold as a unit of product. Both have many problems since the product mix and chemical composition of a given product family changes constantly. The chemical company's product mix also changes over time; thus, the unit of product numbers can cause wide swings in BRIs. The inaccuracies of this measure also contribute to the widely fluctuating BRI's of the coatings company.

The textile manufacturer faced the most difficult unit-of-product decision of our 11 case study firms. The textile company uses pounds of fabric processed in the dyeing and finishing operations. This unit of product can be confounded by a host of factors:

- different fabric weights,
- dye shade (e.g., there are 50 shades of blue and thus pounds of fabric dyed blue is a poor UOP),
- the firm does not record how many pounds of fabric were processed with a given chemical, and
- incoming greige goods often require different types of chemical processing.

Chromium tracking is a good example of their UOP difficulty. The firm estimates that 5% of all chromium use ends up as an emission. The firm also calculates what percent of fabric processes by the company could have been dyed black. Thus fabric weight variations, black shades, and the fabrics that actually was dyed some shade of black confound their unit of product.

There are no simple answers to these unit-of-product challenges. Any attempt to improved unit-of-product tracking (and along with it BRI accuracy) will involve improving production control computer systems. Decisions to make such improvements are rarely driven by the environmental department. Nevertheless, improvements in data collection would provide better information not only for TURA purposes, but also (and more importantly) for key business functions such as loss control, product costing, and inventory management.

5.2.3 Measuring Progress

5.2.3.1 Byproduct Reduction Index

One method for measuring a firm's TUR progress is the byproduct reduction index (BRI). The BRI represents normalized TUR progress in each production unit. To examine the extent to which the BRI measures actual TUR changes (or the lack thereof), researchers performed both qualitative and quantitative analyses of BRI's. Case study firms were asked the level of confidence they had in their BRI's. "High Confidence" connotes a BRI that accurately reflected a production unit's TUR progress (or lack thereof). "No Confidence" connotes a BRI that does not reflect a production unit's TUR progress. Such BRI's included those with large negative values or wide unexplained swings in the data from year to year. "Some Confidence" connotes BRI's that give an indication of a production unit's progress but are not considered very accurate by the firm's environmental manager.

While these categories are somewhat subjective, they help interpret the BRI data. "Low Confidence" BRI's were most often due to small quantities of byproducts (e.g., 150 lbs) normalized by large amounts of production. Even at constant levels of production, these waste quantities can change appreciably -- doubling or halving each year due to equipment cleanouts or extended production runs. Another factor contributing to low-confidence BRI's was the use of poor base year data. No matter how accurate the reporting data has become, BRI's based on poor base year data will compromise a production unit's ability to accurately reflect TUR progress.

Researchers found that BRI confidence was highest for firms making broad-based shifts from solvent products or coatings to water-based products or coatings. BRI confidence was also high for captive operations otherwise using a chemical with integral or no recycling. Continuous processes (as opposed to batch) such as those used by the paper manufacturer tended to have confident BRIs. Another factor confounding BRI confidence was the use of less accurate base-year information.

Batch manufacturers had the greatest difficulty in using the BRI to track progress. These manufacturers often have little use, byproduct, shipped-in-product, and unit-of-product data for each batch produced. The BRI is further complicated in such operations when manufacturing different products in each batch mixture. Table 5-6 delineates the confidence case study firms had that their 1993 BRIs reflected their TUR progress.

Table 5-6 Case Study Firm BRI Confidence

Firm	Number of BRIs	High Confi-dence	Some Confi-dence	No Confi-dence	Comments
Textile Firm	9	0	3	6	Somewhat confident BRI's reflect shift from solvent to aqueous textile coatings. Spurious BRI's are for batch processes with difficult to track byproducts and unit-of-product.
Metal Finishing Firm	11	0	11	0	Firm could guess at reasons for positive or negative BRIs but was not confident in explanations.
Paper Manufacturer	na	na	na	na	Firm reported no byproducts
Chemical Products Manufacturer	57	0	41	16	Offered plausible explanations for BRI's. Negative BRI's chiefly due to changes in estimation procedures and small losses combined with large production volumes.
Diversified Metal Manufacturer	142	51	34	57	Company carefully analyzes and tracks its BRIs and seeks to understand year-to-year shifts in production unit BRI's.
Coatings Manufacturer	26	[illegible]	0	23	Used the miscellaneous code for 18 positive BRI's. With 3 exceptions, could not confidently state BRI reflects actual TUR changes. Eight Chemicals with negative BRI's.
Tape Manufacturer	7	0	7	0	Firm has some confidence that BRI reflects TUR changes but have limited confidence in base-year data
Flexible Web Coater	19	18	1	0	Firm believes BRI's reflect TUR switch to greater use of aqueous coatings.
Plastics Manufacturer	6	6	0	0	Confident that BRI's reflect actual TUR changes -- such as switching from heavy-metal pigments to non-listed pigments.
Iron/Steel Forge	na	na	na	na	Firm reported no byproducts; Firm says it has done no TUR on currently reported chemicals, thus its BRI equals zero. Firm has little confidence in its base-line data.
Leather Processor	4	0	0	4	Don't believe BRI's reflects progress. Firm has entered no codes for positive BRI's since they have made no TUR changes (3 of 4 BRI's are positive).
Total	281	78	97	106	

One firm in the study that made significant TUR progress could not represent this progress using their BRI. In their case, the company generated no byproducts and therefore had a zero BRI. In their case, an input reduction index (IRI) provides a better picture of their progress. Analysis of chemical input data supplied by the company showed significant input reductions per unit-of-product (see Table 5-7). According to the environmental manager, TURA spurred *daily* input per unit of product tracking. Such tracking helped the firm to make improvements in its chemical use efficiency -- resulting in significant chemical cost savings. The paper manufacturer was not the only case study firm to track input data. The metal finisher tracks a monthly IRI. The firm uses the analysis of monthly chemical use to track chemical costs -- costs that comprise a large percentage of the firm's direct manufacturing expenses.

Table 5-7 Paper Manufacturer IRI Chart

Chemical	IRI	BRI
Sodium Hydroxide	54%	no byproducts
Sulfuric	-4%	no byproducts
Calcium Hypochloride	93%	no byproducts
Aluminum Sulfate	59%	no byproducts

Of our eleven case study firms, one firm (diversified metal manufacturer) was keenly interested in using the BRI to track the firm's environmental progress. The firm's environmental manager saw the BRI as a useful diagnostic tool. The manager however modifies the BRI information to track firm progress so that it reflects environmental risk. This and other modifications to the BRI make it then useful for internal purposes -- chiefly to provide feedback for facility and department needs. Every other firm in the study calculated the BRI annually but did not look at the BRI on a more frequent basis. In these cases, the BRI is not useful as a proactive tool for providing real-time feedback to production areas on their environmental improvement projects. We define use of the BRI as a real-time feedback tool as 'BRI Best Practice' and note that only the diversified metal manufacturer used methods similar to such practice.

5.2.3.2 TUR Technique Codes

Another way to measure TUR progress from TURA annual reports is the use of TUR technique codes. TUR technique codes are used to describe increases of five points or more in a production unit's BRI. Such codes are two-part in nature -- the first part describing the TUR method and the second part describing the part of the process where the TUR change occurred. Examples include 'input substitution in processing operations' and 'production unit modernization in finished goods handling'. There are eight TUR methods and three process locations (materials handling/storage, processing operations, and finished goods handling) yielding a total of 24 different TUR technique codes.

Most of the case study firms (nine of the eleven) used the TUR technique codes to describe TUR changes in their production systems. The TUR technique codes did a fair job of representing their TUR changes. Firms often used multiple codes since their TUR projects were multifaceted -- for example, production unit modernization in processing operations and improved operation and maintenance in materials handling/storage. The nature of complex TUR changes to production systems make it difficult to precisely describe these changes with a simple code system. Thus the codes provide a rough picture of the TUR methods and part of the process where these methods have been employed. But this picture is not always accurate.

One problem researchers found with this system was the use of the codes to explain changes in a production unit's BRI that were not caused by TUR changes. With no option to report a code that indicates no TUR changes have been made, most firms in the study reported codes any way. There is no opportunity in annual reports to indicate that the positive change in a production unit's BRI is due not to a TUR change, but caused by some other factor (such as large swings in production or a poorly correlated unit of product). Because BRI's can swing wildly positive and negative year to year (with no actual TUR changes to the production unit), the requirement that firms must account for each five point BRI shift means "false reporting" of TUR technique codes occurs frequently.

5.2.3.3 Chemical Substitution Effects

One often cited issue raised in measuring toxics use reduction progress is chemical substitution. Critics have argued that firms can switch to substitutes that are toxic but are just below the reportable threshold or that are not listed. Our research found relatively little evidence of such substitutions. One company did eliminate acetic acid by switching to unlisted glycolic acid. However this substitution pushed their hydrochloric acid from 8,000 lb annually over the 10,000 lb threshold to 11,000 lb. The switch also introduced the use of phosphoric acid -- a TURA chemical the company previous was not using. This switch was made to reduce the firm's VOC usage and in the technology investigation of the switch, the firm looked explicitly for non-listed chemicals that would provide the same function as acetic acid.

This experience with acetic acid is more the exception than the rule among our 11 case study firms. We found firms looking for safer substitutes to reduce their TURA chemical use without introducing new environmental or employee health and safety risks into the work place. Firms were uniformly sensitive to the TURA list and searched for non-listed substitutes in their TUR project efforts.

5.2.3.4 Facility Reporting Errors

To assess how accurately TURA material balance information reflects actual chemical use and byproduct patterns at the case study firms, researchers performed an analysis of all Form S chemical cover sheet data submitted by the eleven facilities. The first step in the analysis consisted of comparing TURA extract files, generated by TURI, with each Form S submitted to DEP. The comparison enabled researchers to look for data entry and other errors. The comparison also enabled researchers to compare chemical reporting patterns from year-to-year. Such comparisons were helpful in spotting company reporting inconsistencies -- for example one firm had a chemical with no byproducts in one year yet reported byproducts in other years. Researchers brought up these inconsistencies when interviewing case study firms to determine if the inconsistencies were errors or based on true chemical use and byproduct generation patterns.

It is important to understand that researchers did not perform a detailed audit of each case study firm's material balance data. Such an audit would examine purchase, inventory, and use data, measurements and engineering factors used to estimate byproducts and shipped in product calculations, and chemical reaction calculations. One would expect to find further company data calculation and estimation errors with this type of scrutiny. Instead researchers sorted out obvious reporting errors.

Our review found several obvious firm reporting errors (see Table 5-8). The net error was less than one quarter of a percent. However this number is deceiving since firm errors with different arithmetic signs cancel one another. The absolute value of all firm errors changed the total amount of combined use, byproduct, and shipped-in-product by less than two percent.

Table 5-8 Firm Reporting Errors 1990-1993

Category	DEP Extract Files Total (lb)	Absolute Value of Facility Error (lb)	Percent Facility Error (Absolute Value)
Manufacture[1]	3,557,503	2,489,396	70.0%
Process	93,066,747	0	3.8%
Otherwise Used	81,277,404	339,298	0.4%
Byproducts	90,854,323	3,443,231	3.8%
Shipped in Product	74,364,929	21,600	0.0%
Total	343,120,906	6,293,526	1.8%

No single type of reporting error predominated among the eleven firms. As Table 5-9 indicates, these errors ranged from improper chemical balances to mis-reporting of chemical use type (for example, process rather than otherwise used).

[1]The large error for chemical manufacturing is a due to two manufacturing errors among a very small set of chemical manufacturing usage types. The effect is magnified due to the small amount of chemical manufacturing performed by the case study firms.

Table 5-9 Sample of Errors

Error Type	Example	Frequency
Wrong chemical reaction	Assume ammonium hydroxide forms non-listed solids whereas listed byproducts are formed during the reactions	2
Reported a chemical when no chemical should have been reported	Reported manufacturing a metal fume/dust in two years -- error made by a consultant	2
Reported chemical compound as byproduct rather than the metal alone	Report chromium compound byproducts rather than chromium	2
Reported wrong type of use	Reported chemical as processed rather than otherwise used	2
Redefined production units	Consolidated production units from 14 to 8 but did so without creating new production unit numbers	1
Failed to report a chemical for one year (but reported the chemical in other years)	reported MEK in 90, 91, and 93 at amounts well above the threshold; did not report MEK in '92 yet had use over the threshold	1

5.2.3.5 Data Entry Errors (DEP)

To check for DEP data entry errors, researchers compared the Form S's in the firm's DEP file with data generated from the TURA extract files. Researchers found few data entry errors in the chief materials accounting categories of use, byproducts, and shipped-in-product. As Table 5-10 indicates, the total chemical use, byproducts, and shipped in product for the 11 case study firms (127 chemicals) in DEP's extract files was only 0.06% off the actual Form S submittals. While care should be taken generalizing from 11 firms and 127 chemicals it appears that this is not likely to be a large source of error for chemical quantities.

Table 5-10 DEP Data Entry Errors 1990-1993

Category	DEP Extract Files Total (lb)	Absolute Value of Data Entry Error (lb)	Percent Data Entry Error (Absolute Value)
Manufacture	3,557,503	0	0.00%
Process	93,066,747	73,512	0.08%
Otherwise Used	81,277,404	41,761	0.05%
Byproducts	90,854,323	56,632	0.06%
Shipped in Product	74,364,929	23,948	0.03%
Total	343,120,906	195,853	0.06%

Researchers also examined the non-numeric data entered from the Form S reports. Here they found a higher error incidence than that found in materials accounting data. The most problematic errors resulted from the mis-entry of the listing of production units. This occurred for 3 of the 11 case firms. The mis-entry produces a mismatch between a chemical and its production unit records. For example, a chemical with two production units is switched with another chemical with 3 production units. The production unit information (BRIs, chemical use codes, and TUR codes) no longer corresponds to the correct chemical. These data entry errors go unnoticed by industry since they do not receive summary reports of the data DEP has in its database.

One method used by researchers in this report to measure the state's TUR progress is to look at the TUR progress of production units that have been consistently reported from year to year. However, errors using this technique can occur when DEP mis-enters production unit data or when firms incorrectly change their production unit definitions. Of 391 BRI's reported in 1993, 250 had a production unit level data error -- typically the production unit had an incorrect description and/or SIC code. While 219 of the 250 errors were from one firm's report, six of the eleven case study firms had one or more production units with incorrect production unit data in the DEP TURA database. Of the 250 errors, 16 were due to improper consolidation of production units by one firm; 219 appeared to be due to one data entry error where the elimination of one production unit caused a large number of production units to be assigned to the wrong numbers; and 15 were miscellaneous data entry (see Table 5-11). These types of problems are difficult for DEP to identify using standard QA/QC procedures. While they may not affect the overall quantities in the database, they do affect the integrity and interrelationships of the various data elements.

Table 5-11 Sample DEP Data Entry Issues

Error Type	Comments
Incorrect chemical CAS #	1
Missing production unit level data	7 PU's
Failed to enter any data for a chemical	2 chemicals
BRI entered incorrectly or not entered at all	Firm's BRI entered as 100 but was reported as -- 100, 4 missing BRIs
Miscategorization of chemical use type	DEP incorrectly recorded sulfuric acid usage as processed rather than otherwise used. 1 occurrence
PU's incorrectly entered	Case 1: DEP created a PU, as a result PU data for 3 (of 11) chemicals have been entered incorrectly since 1993. Case 2: Miss-entry of PU numbers messed up 25 of 42 PU records.

6 ESTABLISHING A 1987 BASELINE

KEY POINTS

- TURA's 50% byproduct reduction goal is to be measured against a 1987 baseline, however, TURA reporting began in 1990. Therefore, byproduct must be estimated for 1987.
- An estimated 1987 baseline is being developed which builds on the 1987 TRI data. 1987 byproduct is calculated as the sum of the following 1987 quantities:
  1) EPCRA releases and transfers, adjusted using waste treatment efficiencies (from 1987 TRI reports)
  2) Amount recycled on-site, out-of-process (from 1990 reports and survey)
  3) Amount of CERCLA chemicals (from 1990 reports and survey)
  4) Amount from non-manufacturing facilities (from 1991 reports and survey)
  5) Amount from facilities not reporting in 1987 for other reasons (survey)
  6) Adjustments for 1) through 5) from top 20 1990 users (survey)
- Information will be collected from TRI and TURA data, supplemented with information from representative surveys of facilities in each of the above groups.
- A pilot survey indicated that most facilities would be able and willing to provide the data requested in the survey.

6.1 Objectives and Overview

The Toxics Use Reduction Act established 1987 as the baseline from which to measure the 50% byproduct reduction goal; TURA reporting, however, was phased in between 1990 and 1993. As a result, no TURA data exist for the years 1987 through 1989 and the data are incomplete from 1990 to 1993 since no data are available for chemicals and facilities which were phased in over those years. DEP was charged with the task of estimating quantities for those years in which no TURA data exist. A method to develop this baseline was developed over the last year and piloted in the summer of 1995. Data collection and implementation began in the fall of 1995. Although the final baseline data have not been established at this time, this is expected to be completed by April 1996. This chapter describes how the baseline is being estimated and the results of the project to date.

6.2 Sources of Information

The 1987 baseline should include use, byproduct and emission amounts for any TURA listed chemical used in Massachusetts in 1987 above the TURA reporting threshold by any company that employed more than 10 full-time employees in 1987 and is in one of the TURA regulated SIC codes. There are two sources of information that can be used to estimate these quantities prior to the time TURA data was first reported. These are 1) the federal Toxics Release Inventory (TRI) data and 2) the data from the first year a facility or chemical was required to report under TURA.

6.2.1 Federal Toxics Release Inventory Data

TRI data are submitted by facilities on the federal Form R. In 1987, Massachusetts TURA facilities were required to file a federal Form R under TRI if at least 75,000 pounds of a TRI listed chemical was manufactured or processed or 10,000 pounds were otherwise used. Although not all TURA chemicals or SIC codes were required to report under the federal Form R requirements, those facilities responsible for the majority of the total chemical use reported under TURA in 1990 filed a federal Form R in 1987.

Although the Form R does not ask for byproduct per se, the byproduct amount can be calculated or estimated from other information on the form. By definition, byproduct can be calculated as follows:

TURA byproduct =
the quantity of the chemical reported transferred and released under TRI
+ the amount destroyed on-site through treatment,
+ the amount sent out of the process to on-site and off-site recycling and energy recovery.

The 1987 Form R includes quantities transferred and released from the facility and indicates whether or not there was destructive treatment. It does not contain any information on quantities of chemicals recycled on-site or off-site. This information was not reported on the Form R until 1991.

6.2.2 Massachusetts Toxics Use Reduction Act Data

As presented in chapters 2 and 3, the TURA data are available beginning in 1990 with additional industries and chemicals phased in over the next three years. In estimating a 1987 baseline, the gap must be filled between 1987 and the year the chemical was first required to be reported by the facility.

6.2.3 How the Available Data Sources Can Be Used

The TRI and TURA data will be used to estimate the baseline byproduct for all chemicals and facilities that would have reported in 1987 if all facilities currently required to report under TURA had submitted a Form S in 1987. This means that:

- CERCLA chemicals, chemicals added to the TUR list after 1987, and chemicals used by firms in the non-manufacturing SIC codes will be *included* in the 1987 baseline.

- Chemical data from companies that first exceeded the use threshold for that chemical or first employed 10 FTEs *after* 1987 will be *excluded* from the 1987 baseline totals.

- Chemicals that have been (or will be in the future) delisted from the TUR list will be *excluded* from the 1987 baseline totals.

6.2.3.1 TRI Chemical Reports (Form Rs) Submitted in 1987

For Massachusetts TURA filers for which a 1987 Form R was submitted, the 1987 byproduct will be estimated as follows:

- 1987 transfers and releases can be assumed to equal byproduct *if* there is no destructive treatment reported in 1987 *and if* no recycling or energy recovery was reported on the 1991 TRI reports.

- *If* destructive treatment was reported for the chemical, byproduct can be back-calculated from transfers and releases by dividing the portion of the waste stream treated by the efficiency rate of the treatment system.

- *If* recycling and energy recovery activity were reported on the 1991 TRI report (or the first year the chemical was listed), the facility will be contacted to determine if these practices were in place in 1987, and if so, whether the amounts were the same or significantly different than those reported in 1991. The firm's rough recycling estimates will be added to the reported transfers and releases.

6.2.3.2 Form R's Not Submitted in 1987

When no 1987 TRI report is available for a chemical and facility that should be included in the baseline it will be necessary to obtain estimates of 1987 byproduct levels from firms.

Chemical reports in this group include:

- TRI chemicals, manufactured or processed between 10,000 and 75,000 pounds in 1990 (assumed to have also been between 10,000 and 75,000 pounds in 1987),
- chemical reports from facilities in the non-manufacturing TURA SIC codes, and
- chemicals added to the TRI list between 1987 and 1990 and to the TUR list after 1990. (CERCLA chemicals or new TRI chemicals)

This will require contacting facilities to determine:

1) if the firm met the reporting criteria for the chemical in 1987, and if so,

2) whether their 1987 byproduct and use levels were significantly different than those reported in their first year of reporting and if so,

3) a rough estimate of what the byproducts and transfers and releases were in 1987.

6.3 Methodology for Developing Baseline Data

The methodology for establishing a 1987 baseline builds on the 1987 TRI data. 1987 byproduct is calculated as the sum of the following 1987 quantities:

1) EPCRA releases and transfers - estimated from 1987 TRI reports
   - adjust waste streams with destructive treatment using waste treatment efficiencies
2) Amount recycled on-site, out-of-process
   - identify recyclers from 1990 TRI
   - survey random sample of 60 facilities, extrapolate to total universe of recyclers
3) Amount of CERCLA chemicals
   - identify users of CERCLA chemicals from 1991-1993 TURA
   - survey random sample of 60 facilities, extrapolate to total universe of CERCLA users
4) Amount from non-manufacturing facilities
   - identify non-manufacturers from 1991 TURA
   - survey total universe of approximately 40 facilities
5) Amount from facilities not reporting in 1987 for other reasons
   - identify facilities which reported in 1990 but not in 1987
   - survey random sample of 60 facilities (not already included in above surveys)
6) Adjustments for 1) through 5) from top 20 1990 users - this step ensures that the top users are included in the survey

- identify top 20 toxic chemical users in 1990
- survey (if not included in above surveys) to obtain 1987 data

The process to implement the methodology is as follows:

1) Develop a facility survey including what information to seek, in what form, how questions will be phrased.
2) Select facilities to survey. This will include the top 20 toxics users in Massachusetts and a representative sample of other companies.
3) Pilot test the survey to determine if a full survey is feasible and whether meaningful results can be obtained.
4) Review pilot results with TURA Program Evaluation Consultation Group.
5) Proceed with top 20 toxics users.
6) Complete remainder of full survey.
7) Analyze results.

Only the first four steps have been completed at the time. A detailed description of the results of steps 1) through 4) is presented below.

6.3.1 Developing the Survey

In order to obtain the data from facilities that needed to be contacted, an initial survey was developed by DEP to learn whether the information needed would be easily obtainable. DEP did not want to have facilities spend a considerable amount of time on the survey; information that was collected should be readily available at the facility. Exact information was not requested. Rough estimates could be given because many facilities had not collected the data in 1987 or were still unfamiliar with the method of reporting data.

The initial list of companies was chosen from three lists:

- Recycle List - Companies that recycled in 1990,
- CERCLA List - CERCLA chemical users in 1993 that also filed for non-CERCLA chemicals in 1990, and
- No 1987 Data List - Companies that filed in 1990 for which DEP had no 1987 data

The companies on the Recycle and CERCLA lists were selected by first determining which chemicals had been reported by the greatest number of users. The top 5 CERCLA chemicals (excluding Sodium Hydroxide - it was reportable as an EPCRA/TRI chemical in 1987) and 9 recycled chemicals were identified. (see Table 6-1) For each of these top chemicals, a high quantity and a low quantity user was chosen. The chemicals on these two lists are shown in Table 6-1. Companies were selected from the No 1987 Data list at random.

Recycled and CERCLA Chemical Lists for 1987 Survey

Recycled Chemical List	CERCLA Chemical List
Acetone	Potassium Hydroxide
Chromium	Acetic Acid
Copper	Butyl Acetate
Freon 113	Ethyl Acetate
Methyl Ethyl Ketone (MEK)	Aluminum Sulfate
Acetic Acid	
Butyl Acetate	
Ethyl Acetate	
Aluminum Sulfate	

Table 6-1

DEP also attempted to get some companies that were on one of the lists, some that were on two of the lists, and some that were on all three of the lists. The sample ended up including

- companies on both the CERCLA and the Recycle lists,
- companies on both the CERCLA and No 1987 Data lists, and
- companies on all three lists (CERCLA, Recycle and No 1987 Data).

DEP also selected companies that used many chemicals and companies that only used a few chemicals.

6.4 Development and Results of Pilot Survey

In August 1995, DEP piloted a survey for gathering 1987 estimates. Twenty-five companies were in the original sample. Of these, one had gone out of business and seven could not be used in the pilot (five contacts were on vacation, one facility was dropped because the data were unclear, and one facility had no appropriate contact). Of the remaining 17 facilities, five facilities provided answers either by completing the survey and returning it or by answering questions on the phone.

Respondents agreed to participate readily in the survey. The individuals who responded included environmental managers, presidents of companies, and certified Toxic Use Reduction Planners. Usually respondents requested that the survey be faxed to them and then called back to say when they could provide the data. All but one respondent felt that the information was readily available. One firm had purchased the facility in 1990 and had no records from 1987.

The results of the pilot survey were brought for review to the TURA Program Evaluation Consultation Group. This group of government, business, and environmental leaders evaluated the survey results and concluded that DEP should continue with its proposed methodology to obtain data. The survey was updated slightly in order to make it easier for survey respondents to understand the layout of the survey. Assistance was given to DEP by a survey expert in developing the questions and determining the sample size. This updated survey was sent for review to the evaluation group members on September 12, 1995. Responses were positive.

6.5 Plan and Schedule for Full Survey and Analysis

6.5.1 Methodology

One possible methodology was to survey just the top twenty filers for the 1987 baseline, because this group makes up such a large percentage of the chemical use by manufacturers. However, the objective was to fairly represent all industrial manufacturers who have been working on the goal of 50% reduction of byproduct for the Commonwealth. This could only be obtained by surveying a sample from facilities in a number of different SIC codes. As a result, three different groups of facilities were included in the survey.

The top twenty filers based on total use reported in 1990 constituted the first group of facilities. This group is being surveyed because they make up 76% of the total use in the Commonwealth of Massachusetts in 1990.

The non-manufacturers are the next group of facilities. There are forty-one facilities in this group. All of these facilities will be surveyed because they are a very diverse group.

The final list is a random selection of facilities from the initial three lists: companies that recycled in 1990, CERCLA chemical users in 1993 that also filed in 1990, and companies that filed in 1990 for which DEP has no 1987 data. It was determined with the help of the survey expert that surveying 60 facilities from each of the three initial lists would provide a sufficient number of respondents to ensure a representative 1987 baseline. Companies were chosen on a random basis by using a standard random chart. If the randomly selected company had already been surveyed on the pilot survey or had already been chosen for one of the other lists, the next available company was chosen until 60 were selected for each group.

In order to make the process of responding to the survey as simple as possible for the facilities, the DEP gathered as much existing data for each facility prior to the first contact. Where applicable, this information included 1987 and 1990 reported TRI data and 1990-1993 reported TURA data.

6.5.2 Status of Full Survey

Because of time constraints, DEP chose to begin the survey with the top twenty user facilities and those randomly chosen from the Recycle list. The remainder of the facilities will be surveyed in the near future and the results will be made available in April 1996.

At this point, the top 20 companies have been surveyed. Of the 14 top user facilities that were contacted for the survey in the time prior to the writing of this report, 2 did not fit the survey criteria, 3 facilities had closed, and 1 facility had already given DEP necessary data without the survey. Eleven facilities eventually completed the survey although 6 facilities required numerous phone calls to obtain the information.

When this report was written, 43 of the total 60 recycle list facilities had been contacted, and completed surveys had been received from 18 facilities. Managers at three facilities have said they will not be completing the survey, one facility had no one available at the facility at this time to collect the data, and two facilities considered it to be too much work.

In general, respondents to this survey were as willing to help as those that completed the pilot survey. This time, however, more time was needed to complete the survey due to deadlines for other regulatory reporting requirements. Survey respondents did say they would cooperate once their other mandatory reporting obligations were fulfilled. The types of respondents were the same as the pilot survey. Survey respondents wished to have the survey faxed to them. Most responded by faxing the survey back several days later.

6.5.3 Schedule for Remaining Tasks

The work which remains to be completed includes: 1) finish surveying top 20 and recyclers, 2) create spreadsheet to store and analyze data collected, 3) receive information and input into spreadsheet, 4) analyze results, and 5) repeat process for remaining 180 companies. Steps 1 through 4 will be completed by February 2, 1996. Step 5 is scheduled to be completed by April 2, 1996. The result will be the establishment of a 1987 baseline, from which progress to 1990 and other first reportable years can be estimated.

7 METHODOLOGY OVERVIEW

KEY POINTS

- The methodology for measuring Massachusetts TUR progress includes normalized and non-normalized quantitative measures.
- The quantitative measures analyze the byproduct generated, total use (amounts manufactured, processed, and otherwise used), amount shipped in product, amount released to the environment and amount transferred off-site.
- Changes in reporting requirements were allowed for by calculating progress for different subsets of the TURA data, termed "universes." Each universe included facilities and chemicals that were consistent over the years for which progress was measured.
- Normalization for changes in production was done by using the TRI production ratio to calculate expected quantities. Expected quantities are the amount of toxic chemical which would have been expected in the second year without TUR. When the expected is larger than the actual quantity, the difference is assumed to be due to TUR.
- Because of issues around quality, consistency and useability of the BRI data, the study focused on BRI "reality check," rather than BRI analysis.
- The methodology also includes the analysis of subsets of chemical groups and industry groups

7.1 Introduction

Based on the results of previous studies and the analysis of data availability, a methodology consisting of multiple metrics was developed. The multiple metrics respond to the different goals of TURA, and also provide a comprehensive measurement tool. A comprehensive tool provides metrics which provide overall measures, as well as those which draw out the reasons behind overall trends. In addition, multiple metrics produce a more robust methodology. Comparing the consistency of trends across metrics can either bolster confidence in the results, or indicate problems in the analysis. The methodology includes measures of :

- actual changes in quantities,
- changes in quantities normalized for changes in production,
- changes in quantities for specific groups of chemicals,
- changes in quantities for specific groups of facilities, and
- qualitative indicators of TUR activity.

Toxic chemical quantities examined include: byproduct generated, used, shipped in or as product, released to the environment and transferred off-site.

7.1.1 Quantitative and Qualitative Measures of Progress

There are two ways to measure state-wide progress in toxics use reduction--qualitatively and quantitatively. Qualitative measures look at the characteristics of what is reported without detailed analysis of the numerical data. Qualitative measures will indicate *if* TUR activity is taking place but will not be able to say specifically *to what extent* the TUR activity is responsible for reductions in the use of toxics and generation of byproducts. Quantitative measures analyze the numerical data reported. Quantitative measures provide answers to the question of *how much* effect TUR efforts are having. Qualitative measures are particularly useful for validating or invalidating quantitative results. This project concentrated on quantitative measures although some qualitative measures were reviewed.

7.1.2 Normalized and Non-Normalized Measures of Progress

Using the TURA and TRI data to quantify state-wide progress in TUR is a difficult task because changes in quantities reported can be caused by a number of factors, including:

- increases and decreases in production,
- changes in production processes or products, and
- changes in product mix.

Any or all of these could be related to TUR efforts; they could also be related to economic factors. Since the goal of TURA is to decrease toxics use and byproduct generation, not decrease economic activity, measures need to be developed which factor out non-TUR effects. A *non-normalized* measure uses the gross numbers being reported. This type of measure will show whether the overall trend is increasing or decreasing and will provide an indication of total toxic chemicals used and byproduct generated in the Commonwealth. In contrast, a *normalized* measure attempts to factor out the influence of events other than TUR that could also cause the reported gross numbers to increase or decrease. Normalized measures indicate whether reductions in byproduct and emissions are the result of TUR or declining production.

7.2 Development of Measurement Methodology

Because of the complex nature of the TURA data, the methodology used here consists of two basic quantitative calculations performed on several different quantities for many different subsets of the TURA data. The calculations measure the actual changes in reported quantities and compares them to a normalized or 'expected' change based on reported production levels. The calculations and the quantities on which they are performed are described below. Qualitative measures are described in Section 7.2.2.

These measures show progress (or lack thereof) in different segments of the data. The segments are referred to as 'universes.' This segmentation is necessary because of differences in what is reported each year. It is not possible to measure change when what is reported in two different years is different. Therefore, the methodology measures progress in individual universes and compares and contrasts the results for different universes. Taken together, the measures provide an overall picture of progress as well as an indication of how much and where that progress is being made.

The different universes were created to determine the extent to which the measurements are affected by the data availability and useability described in Chapter 3. In some cases, a universe includes records for all chemicals that were reported by a facility over a number of years. In other cases, a universe includes only records that would have been reported if facilities and chemicals met specific reporting criteria. The universes measure:

- Overall Progress
  - based on when reporting was first required
  - based on data actually reported in two consecutive years
- Progress by subsets of facilities:
  - those that reported all four years
  - those that reported the same chemicals all four years
  - those that reported the same chemicals in the same production unit all four years
  - comparison of large versus small toxics users
- Progress by subsets of industries
- Progress by subsets of chemicals

How each universe is defined and which reporting issues it is intended to address is described in more detail in section 7.2.3.

7.2.1 Quantitative Measures - Actual and Normalized

The TURA and TRI quantities which were used for non-normalized and normalized measures include:

- total toxic chemicals used (manufactured plus processed plus otherwise used),
- toxic byproducts generated,
- toxic chemicals shipped in or as product, and
- toxic chemicals released or transferred.

These quantities are totaled for different universes prior to performing the measurement calculations. For example, if measuring the change in byproduct, the total of all the byproducts reported for all facilities and chemicals in the universe is calculated and then the calculations described below are performed.

Actual or non-normalized measures look at the trend in the actual quantities reported. Actual progress is the change in a quantity reported between a beginning year and an ending year:

$$\Delta Q = Q_1 - Q_2 \tag{7.1}$$

where:

ΔQ = change in quantity reported, lb
Q_1 = the quantity reported in the beginning year, lb
Q_2 = the quantity reported in the ending year, lb

The percent change in quantity reported is given by:

$$R = 100\frac{Q_1 - Q_2}{Q_1} = 100\frac{\Delta Q}{Q_1} \tag{7.2}$$

For example, if the total amount of byproduct reported by all facilities and chemicals in a given universe is 200,000 pounds in the first year of reporting and 160,000 pounds in the last year of reporting, the actual change is:

ΔQ = 200,000 - 160,000 = 40,000 lb actual reduction (7.1)
R = 100 x (200,000 - 160,000) / 200,000 = 20% actual reduction (7.2)

However, the change in actual numbers alone is not necessarily a good indication of toxics use reduction because these quantities can change for other reasons than TUR. The gross quantities reported need to be adjusted or normalized to take changes in production levels into account. Two different normalization methods were tested, one using the TURA BRI and the other using the TRI production ratio (PR). Both methods are described below but due to data quality, useability and consistency issues described in Chapters 3 and 4, only the production ratio was used for normalizing data in the final study.

7.2.1.1 Weighted Average Production Ratio

This methodology assumes that changes in production result in directly proportional changes in the quantities of chemical used and byproduct generated. It also assumes that the production ratio (PR) is a reasonable reflection of how production changed from one year to the next. The PR reported on the TRI Form R is the change in production of the current year relative to the previous year. If the production ratio is less than 1, then production has decreased since the prior year. If the production ratio is greater than 1, then production increased. If no TUR changes are made at a facility, then the changes in reported quantities would be due to changes in production levels. The 'expected' quantities due to changing production levels can be calculated based on the facility's reported production ratio. Comparing the "expected" quantity if no TUR occurred to the actual quantity reported on Forms S and R would show the change attributable to TUR. Thus the "normalized" change is the quantity avoided due to TUR activities.

Given the actual amount reported in one year and the amount that production changed in the second year, the 'expected' quantity for any particular facility-chemical pair in the second year is:

$$Q_e = Q_1(PR_2) \tag{7.3}$$

and the normalized reduction or amount avoided is:

$$Q_n = Q_e - Q_2 \tag{7.4}$$

where:

Q_n = normalized reduction, quantity avoided due to TUR
Q_e = quantity expected to be reported in the second year,
Q_1 = quantity actually reported in the first year,
Q_2 = quantity actually reported in the second year, and
PR_2 = production ratio reported in the second year.

Given as a percent, the relative quantity avoided is:

$$R_n = 100\frac{Q_e - Q_2}{Q_e} = 100\frac{Q_n}{Q_e} \tag{7.5}$$

For example, if 100,000 lb of toluene is used in one year and the following year's production increases by 10% (PR = 1.1) the toluene use would be expected to go up 10% as well to 110,000 pounds. If instead the toluene use only goes up 5%, to 105,000 pounds, the methodology assumes that TUR is responsible for avoiding 5,000 pounds of toluene. (The actual quantity is subtracted from the expected quantity to determine the amount avoided due to TUR activity.)

Mathematically,

$$Q_e = Q_1(PR_2) = (100{,}000\,lb)(1.1) = 110{,}000\,lb \tag{7.3}$$

$$Q_n = Q_e - Q_2 = 110{,}000\,lb - 105{,}000\,lb = 5{,}000\,lb \tag{7.4}$$

$$R_n = 100\frac{Q_n}{Q_e} = 100\frac{5{,}000\,lb}{110{,}000\,lb} = 4.5\% \tag{7.5}$$

These formulas work only for an individual facility-chemical pair when an actual quantity is reported both in the first and second year and a PR is reported for the second year. However, the purpose of the methodology is to allow measurement of industry or state-wide progress, not individual facility progress. Since many of the universes include facility-chemical pairs that were not reported in two consecutive years, the methodology needs to account for missing data and needs to estimate the effect of missing data on the results.

In order to allow for missing data, the methodology calculated an 'average' production ratio based on the reported production ratios. The methodology weights the individual production ratios based on the total use reported for each production ratio.

The weighted average production ratio (PR_{WA}) was calculated by using all records within a given universe that had a first year quantity and a second year production ratio as follows:

$$PR_{wa} = \frac{\sum (PR_{2i})(TU_{1i})}{\sum TU_{1i}} \tag{7.6}$$

where

i = all records in universe with a non-zero total use in year 1 and a PR > 0 in year 2
PR_2 = production ratio for an individual record in year 2
TU_1 = total use (manufactured + processed + otherwise used) for individual record in year 1

Equation 7.6 gives an approximation of the average production ratio for all the records in the universe. Once the PR_{WA} has been calculated, it can be used to calculate the expected quantities for the entire universe:

$$Q_E = Q_{T1}(PR_{wa}) \tag{7.7}$$

and the normalized reduction or amount avoided is then:

$$Q_N = Q_E - Q_{T2} \tag{7.8}$$

where:

Q_N = total quantity avoided due to TUR, lb
Q_E = total quantity expected to be reported in the second year, lb
Q_{T1} = total quantity actually reported in the first year, lb
Q_{T2} = total quantity actually reported in the second year, lb
PR_{WA} = weighted average production ratio

Given as a percent,

$$R_N = 100\frac{Q_E - Q_{T2}}{Q_E} = 100\frac{Q_N}{Q_E} \tag{7.9}$$

These calculations are applied to the records in each universe to determine the progress made by each universe.

Normalized Quantity Change Example

Facility-Chemical Pair	First Year		Second Year		
	Total Use	Byproduct	Total Use	Byproduct	PR
1	100,000	50,000	105,000	50,000	1.1
2	200,000	20,000	220,000	22,000	1.15
3	50,000	10,000	50,000	7,000	0

Table 7-1

For example, given a universe with only the three facility-chemical pairs shown in table 7-1, the actual and expected changes would be as follows: (note that facility-chemical pair 3 has a PR=0 and so is not included in the PR_{WA} calculations)

$$PR_{wa} = \frac{(1.1)(100{,}000lb) + (1.15)(200{,}000lb)}{(100{,}000lb + 200{,}000lb)} = 1.13 \tag{7.6}$$

The total byproduct in year 1, Q_1, is 50,000 + 20,000 + 10,000 = 80,000 lb

The total byproduct in year 2, Q_2, is 50,000 + 22,000 + 7,000 = 79,000 lb

Substituting these into Eq. 7-1 gives the actual change in byproduct produced:

$$\Delta Q = Q_1 - Q_2 = 80{,}000lb - 79{,}000lb = 1{,}000lb \tag{7.1}$$

From Eq. 7.2, the percent reduction is:

$$R = 100\frac{\Delta Q}{Q_1} = 100\frac{1{,}000lb}{80{,}000lb} = 1.3\% \tag{7.2}$$

The expected byproduct reduction is given by Eq. 7.7:

$$Q_E = Q_1(PR_{WA}) = (80{,}000\ lb)(1.13) = 90{,}400\ lb \tag{7.7}$$

The total byproduct avoided (Eq. 7.8) is:

$$Q_N = Q_E - Q_2 = 90{,}400lb - 79{,}000lb = 11{,}400lb \tag{7.8}$$

Finally, the percent byproduct avoided (Eq. 7.9) is:

$$R_N = 100\frac{Q_N}{Q_E} = 100\frac{11{,}400lb}{90{,}400lb} = 12.6\% \tag{7.9}$$

For this exceptionally small universe, the actual reduction in byproduct was only 1,000 pounds from the first year to the second year, a little more than 1% of the total byproduct generated in the first year. However, when the numbers were normalized for changes in production, the change was more dramatic. The amount of byproduct avoided was 11,400 pounds or almost 13% of the amount expected.

This method builds in the assumption that production at the group of facilities for which PR=0 is approximately equal to the calculated weighted average production ratio. If that is not the case, then normalized progress will be over- or under-stated, depending on the actual production levels at those facilities. The magnitude of the effect of this missing production unit data will depend on the magnitude of the missing information and actual production levels at those facilities. As discussed in Chapter 4, *Data Consistency Check*, analysis showed that in cases where the universe included many records, the amount of missing data was small enough for this metric to result in a reasonable estimate of progress. However, for small universes, errors and inconsistencies in the data resulted in questionable results.

7.2.1.2 Weighted average BRI

A calculation for a weighted average BRI was also developed for the different universes analyzed in this project. The calculation was similar to that for the weighted average PR but used a different set of data and different ranges. Because the BRI is based on the changes from a base year to a final year, the weighted average BRI was calculated for records with a common base year, not two consecutive years. Also, the records had to have valid BRIs. The calculation was weighted on total use:

$$BRI_{wa} = \frac{\sum (BRI_{2i})(TU_{1i})}{\sum TU_{1i}} \qquad (7.10)$$

where:

i = all records in universe with:

- a non-zero total use in year 1,
- chemical used in only one Production Unit in both years,
- a non-zero BRI, and
- base year = constant (i.e., all records with base year = 90 or all = 91, etc).

BRI_2 = byproduct reduction index for an individual record in year 2

TU_1 = total use (manufactured + processed + otherwise used) for individual record in year 1

Once the weighted average BRI was calculated for a universe, it could be used to calculate the expected change in the byproduct from one year to the next. As with the weighted average production ratio, the accuracy of this calculation depends on there being only a small amount of missing data. However, it turned out that this was not the case. Because this universe (Universe 2) contains less than one half of the quantities reported overall, data errors and anomalies have a significant effect on the results. Therefore, the weighted average BRI was not used to measure progress on the existing TURA data.

7.2.2 Qualitative Measures

A qualitative measure of TUR progress shows whether or not TUR activity is taking place but will not show how much. Qualitative measures help to validate the general accuracy of the quantitative measures. The two qualitative measures included in this methodology were reported BRI/ERIs and reported TUR technique codes.

A positive BRI or ERI indicates that less byproduct or emissions are being generated per unit of product produced. The highest possible BRI or ERI is 100 and means no byproduct is being generated although product is still being produced. A negative BRI or ERI indicates that a product is being produced less efficiently, i.e., more byproduct is being generated per unit of product than in the base year. A qualitative measure of TUR is the change in the number or percent of production units with a positive BRI or ERI reported each year compared to the number of zero or negative BRIs and ERIs. Because reporting is not required in years when use is below the reporting threshold, this metric underestimates TUR activity. For example, the final BRI=100% for a production unit is typically only reported if the chemical is still being used in other production units over the reporting threshold.

The TUR technique codes are reported for a production unit if the BRI reported for the current year is 5 or more points greater than the BRI reported for the previous year. Another qualitative measure of TUR is the change in the number of TUR technique codes reported each year and the number or percent of production units for which they are reported.

Because of the issues around quality of these data, this study focused on "reality checking" the BRI and TUR technique codes, rather than analyzing them.

7.2.3 Universes and Subsets of Reported Data

Two approaches were taken in order to ensure that the measurements were dealing with consistent subsets of the data. The two approaches are similar in that both measure progress in data sets that are consistent over two or more years. Both approaches also result in several different measures that cannot be rigorously combined into a single result. The differences in the approaches are what years and which reporters were held constant in each set.

7.2.3.1 Universes of TURA Data

The first approach was to separate industries and chemicals into consistent sets or universes based on when they were first required to be reported as follows:

1990 Reportables - EPCRA chemicals, SIC 20-39
1991 Reportables - additional SICs, first third of CERCLA chemicals
1992 Reportables - second third of CERCLA chemicals
1993 Reportables - third third of CERCLA chemicals (only one year of data)

Progress for each universe could then be evaluated over whatever years worth of data were available for that universe.

This approach results in 3 different metrics, one for each set of reportables for the years 1990 to 1992:

- 1990 Reportables from 1990 to 1993,
- 1991 Reportables from 1991 to 1993, and
- 1992 Reportables from 1992 to 1993.

The measures for each of these universes cannot be combined in a rigorous way, because they each have a different base year. (See Figure 7-1.) [1] These universes are discussed in more detail in Appendix I.

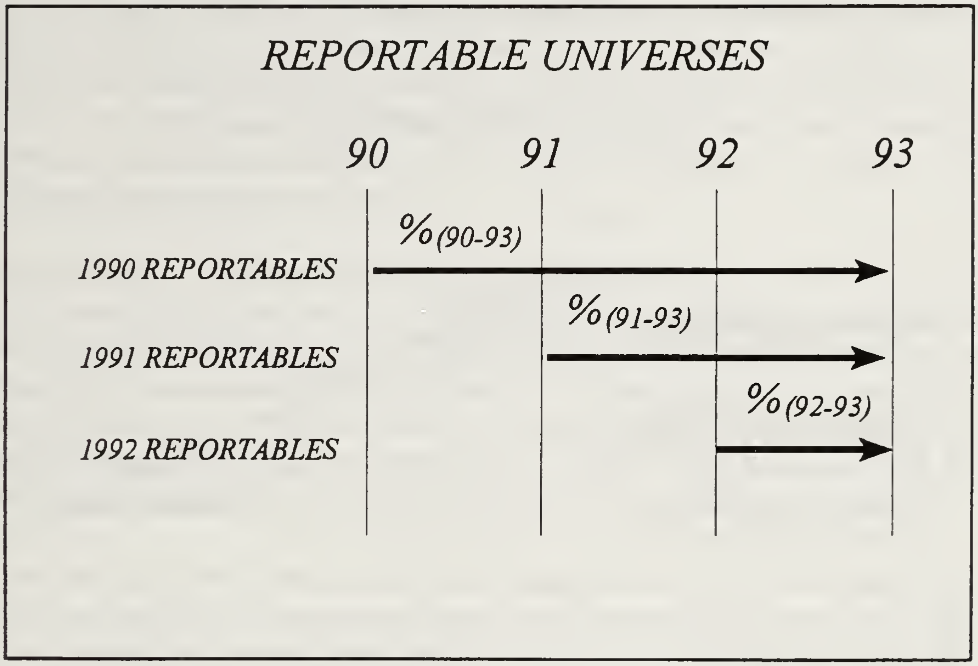


Figure 7-1

The second approach was to look at each of two successive years and look at a consistent set of industries and chemicals reportable in both years:

[1]Because the 1993 Reportables have only been reported for one year, it is not possible to measure trends with those data. However, as additional years worth of data become available for 1993 Reportables, they will be added to the methodology.

- Everything reported in both 1990 and 1991,
- Everything reported in both 1991 and 1992, and
- Everything reported in both 1992 and 1993.

This approach results in three successive percent changes for each of the three sets of years, but again, they cannot be combined in a rigorous fashion because each has a different baseline quantity. (see figure 7-2)

Although there is no rigorous way to create a single percent change over four years for all reportable industries and chemicals, it is possible to look at the disaggregated percentages and get a feel for overall progress. If it is assumed that no TUR progress or any other changes took place in the years when industries or chemicals weren't reportable, then a weighted average of the three percentages can be calculated to give an approximate four year percent change. When the 1987 baseline work is complete, it should be possible to fill in missing years with estimates of progress to arrive at one measure for all years, all industries, and all chemicals.

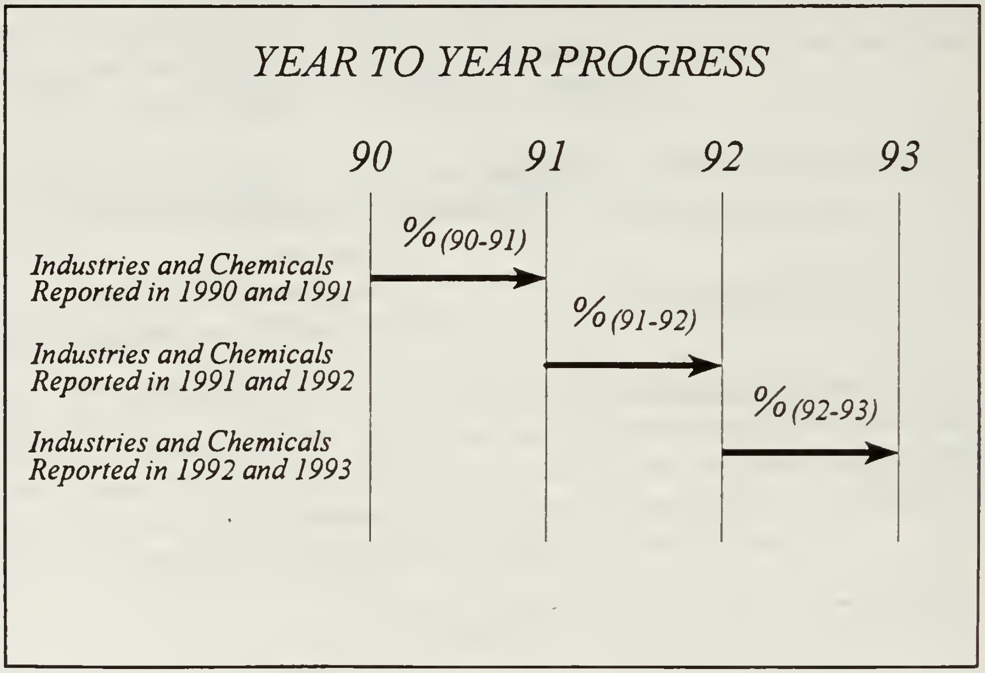


Figure 7-2

7.2.3.2 Progress by Subsets of Facilities

In addition to chemicals and facilities being phased in over several years, facilities may start or stop reporting chemicals because of changes in the quantity being used or the number of employees. When a facility or chemical drops out of or moves into the reporting universe, the change in quantity reported may hide changes related to TUR or may look like TUR is occurring when it is not. The methodology also looked at changes in certain subsets or universes of the data designed to take some of these changes into account. The facility subsets that were used and what they were intended to show are described below. (see Appendix I)

- **Facilities that reported in all four years**. (Universe 4) Included in this universe were any facilities that reported at least one chemical in all four years (although not necessarily the same chemical in each year). Since these facilities reported in all four years, it is known that they did not go out of business during that time and that they met the employment thresholds and the chemical use threshold for at least one chemical. This universe provides some insight into the effect on the methodology results of facilities that move in and out of the reporting universe because they begin operation or cease operation or because they fail to meet the reporting requirements.

- **Facilities that reported the same chemical in all four years**. (Universe 3) Included in this universe were the records for each chemical that a facility reported in all four of the reporting years. Not included were chemicals that the facility reported for less than four years. This universe provides some insight into the effect on the methodology results of chemicals that move in and out of the reporting universe because a facility no longer uses them or uses them at levels below the reporting threshold. It also excludes chemicals that a facility starts to use part way through the four reporting years.

- **Facilities that report the same chemical in only one constant production unit for all four years**. (Universe 2) To be included in this universe, a facility must report a chemical in all four years, in all four years the chemical must be used in only one production unit, and that production unit does not change over the four years of reporting. This universe provides insight into the usefulness of the BRI and ERI in measuring progress at the facility level since if a chemical is used only in one production unit, the BRI for the production unit is the same as the BRI for the facility-wide use of that chemical.

- **Few large chemical users versus many small chemical users.** The few large toxic user facilities that account for the majority of the reported use quantities are compared to many smaller use facilities that account for a smaller percentage of the reported quantities. This comparison provides insight into the effect that a few companies have on the overall TUR progress.

7.2.3.3 Progress by Subsets of Chemicals and Industries

The methodology also allows a way to measure progress for specific chemicals or sets of chemicals and industries or groups of industries.

The following chemical groups were analyzed (see Appendix B2):

- Acids
- Metals
- Carcinogens
- Montreal Protocol (ozone-depleting chemicals)
- Swedish Chemical List (Geiser and Rossi, 1995)
- US EPA 33/50 Chemicals (US EPA, 1995, *1993 Toxics Release Inventory Public Data Release*)
- Chemicals which are mostly processed
- Chemicals which are mostly processed and otherwise used

The broad objective of chemical group analysis is to determine if certain groups are making more or less progress than others. This helps assistance programs target resources, and informs policy decisions. In addition, examining the data in smaller subsets often reveals inconsistencies which would not be noticed when calculating overall measures.

The industry progress analysis was based on a facility-wide SIC code assigned to each facility. Because most facilities have multiple 4-digit SIC codes which apply to them, and because accuracy and clear definition of 4-digit SIC codes are in question (Section 2.3.1), this study used a "user segment" SIC grouping. This is a draft experimental grouping of 2-, 3-, and 4-digit SIC codes prepared by the TURA User Segment Advisory Subcommittee. Groups are created which contain similar types of products manufactured or services provided. The level of detail chosen (e.g., 2-digit vs. 4-digit) depends on the number of Massachusetts companies in that category, and the uniqueness of their products, substrate materials and processes. Objectives are to group facilities which might be able to use similar TUR options and facilities for which TUR progress could be compared. It should be noted that the list of groupings used for this project (see Appendix C) is an early draft and has not undergone any review.

8 DATA ANALYSIS RESULTS

KEY POINTS

- Total reported quantities of toxic chemicals used, generated as byproduct, shipped in product, and released or transferred have increased over the period 1990 to 1993. However, this increase is misleading. It occurs because of the expanded list of industries required to report in 1991 and the phasing in of the CERCLA chemical list from 1991 to 1993.
- For a consistently reportable universe of industries and chemicals (excluding trade secret data) over the period 1990 to 1993 (i.e., 1990 Reportables or Universe 0), quantities of toxic chemicals used, generated as byproduct, and released or transferred have decreased, while quantities shipped in product have increased. Within TRI releases and transfers, releases to the environment and transfers to POTW's have decreased, while other off-site transfers have increased.
- The '1990 Reportables' group experienced an actual reduction in toxic chemical byproduct generated of 13% from 1990 to 1993 and an actual reduction of 17% in total toxic chemical use. When reductions are normalized to account for changes in production levels, there is a reduction of 14% in byproduct generated and 19% in total use.
- The 'top 20 use' facilities for 1990 represented less than 4% of the facilities reporting, but accounted for over 70% of the total use and 40% of the total byproduct reported in 1990.
- The 'top 20 use' facilities experienced an actual reduction in total toxic chemicals used of 23% (148 million lb)from 1990 to 1993. However, reported production ratios suggest that some of the decrease was due to decreased production levels. Consequently, their normalized reduction in total use was only 20% from 1990 to 1993. Similarly, 'top 20 user' facilities experienced an actual reduction in byproduct generated of 9% (3 million lb) and a normalized reduction of 5%.
- The 'non-top 20 use' facilities experienced only a 2% reduction in actual total toxic chemical use (4 million lb), but reported production ratios suggest increased production levels. Therefore, the 'non-top 20 toxic user' normalized reduction in total use was calculated at 17% for 1990 to 1993. Similarly, the actual reduction in byproduct generated by the 'non-top 20 user' facilities was 15%, while the normalized reduction was 28%.
- Facilities using and reporting the same chemicals consistently over 4 years experienced a reduction in toxic chemical byproduct generation of approximately 8%, compared with a 13% reduction for all facilities. This indicates that chemicals dropping below or rising above the reporting threshold may overstate actual progress by as much as 5%, depending on what their actual quantities are in the years in which they are not reported.

8.1 Introduction

The complexity of the TURA data makes it difficult to provide a single, simple answer to the question: How much progress has been made in Massachusetts in toxics use reduction? Figure 8-1 presents total data for six quantities reported by TURA filers: manufactured, processed, otherwise used, generated byproduct, shipped in product, and TRI releases and transfers (emissions). Based on the total amounts reported each year, there is no TUR progress evident. Although the reported quantity manufactured has decreased, all other quantities reported in 1993 are greater than the 1990 reported quantities. Some, such as 'Shipped in Product', are significantly higher. Table 8-1 shows the actual quantities involved.

The data show an apparent increase in reported quantities. However, what Figure 8-1 does not show is how much of this trend is due to the expanded list of industries required to report in 1991 and the phasing in of the CERCLA chemical list from 1991 to 1993. The chemicals and industries subject to TURA reporting requirements in 1990 through 1993 are as follows:

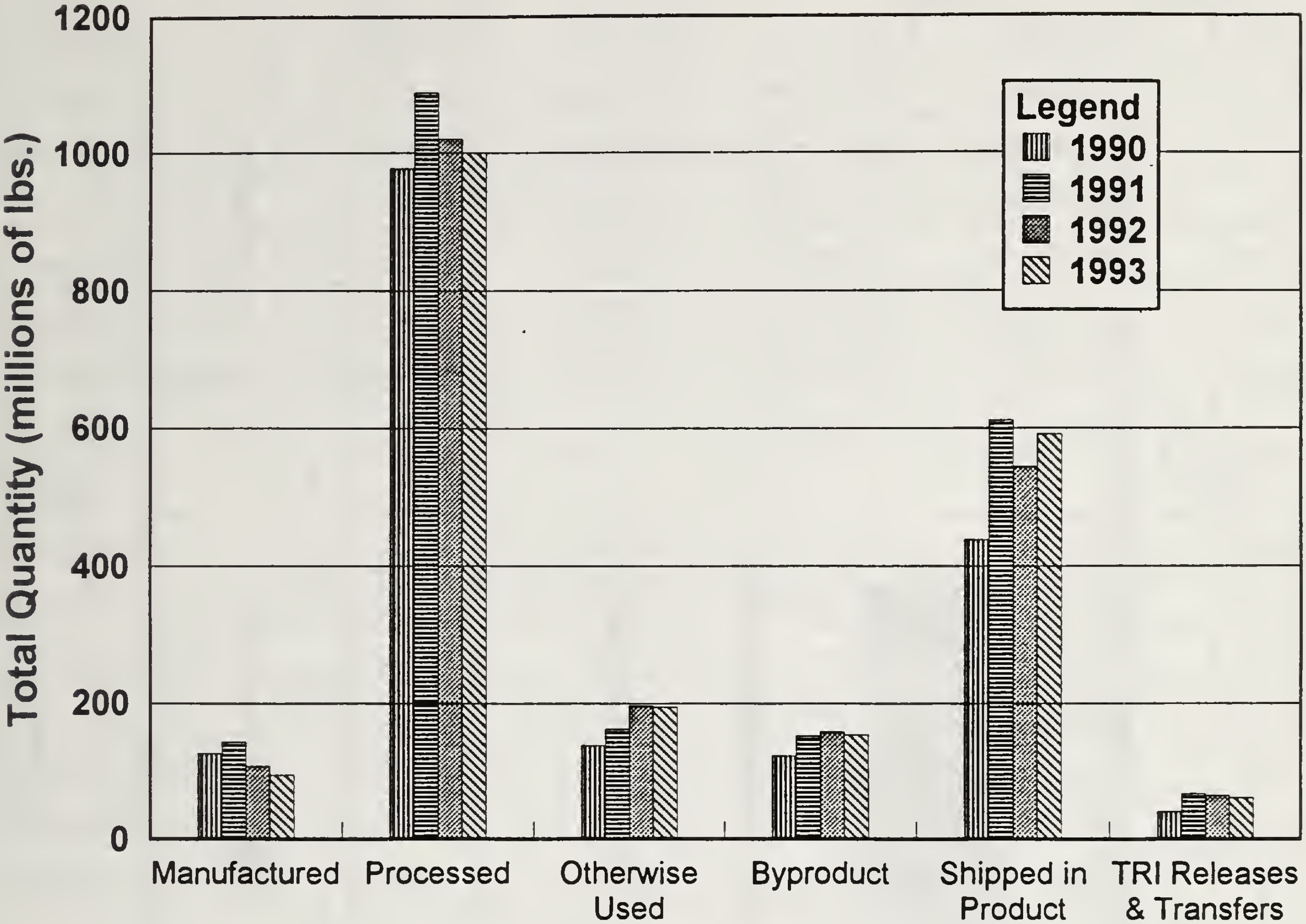
- 1990 - EPCRA chemicals, facilities in the manufacturing SIC codes (20 to 39),
- 1991 - 1990 Reportables plus the 1st third of CERCLA chemicals and facilities in SICs 10-14, 40, 44-51, 72-73, 75-76,
- 1992 - 1990 and 1991 Reportables plus 2nd third of CERCLA chemicals, and
- 1993 - 1990, 1991 and 1992 Reportables plus 3rd third of CERCLA chemicals.

These changes in reporting requirements complicate the task of measuring progress because there is no information for years prior to a chemical or facility's first required reporting year. Figure 8-2 shows this graphically. The lightest shaded area is the portion of the data prior to the first required reporting year. This portion will have to be estimated to establish a common 1987 baseline. The darkest portion is what has actually been reported to date and therefore can be analyzed. The unshaded portion will be reported in the future. As described in Chapter 4, work is being done to establish an estimated 1987 baseline for the TURA data. However, the results of that portion of the project are not yet available. This chapter only reports on progress from the point a facility or chemical was first required to report.

8.2 Universes of TURA Data

Because of the lack of a complete data set and because of inconsistencies between the available sets in terms of when data first was reported, progress can only be measured for subsets of the data, which are referred to in this report as universes. Detailed information about these universes is given in Appendices I and J. Briefly, the universes for which progress has been reviewed are as follows:

All TURA - including Trade Secret



	Manufactured	Processed	Otherwise Used	Byproduct	Shipped in Product	TRI Releases & Transfers
1990	126.	977.	138.	123.	438.	40.4
1991	143.	1,088.	162.	152.	611.	66.5
1992	108.	1,021.	196.	158.	544.	64.7
1993	94.4	1,000.	194.	154.	591.	60.8

Universe : All TURA including Trade Secret data
Quantities in Millions of lbs.

Figure 8-1

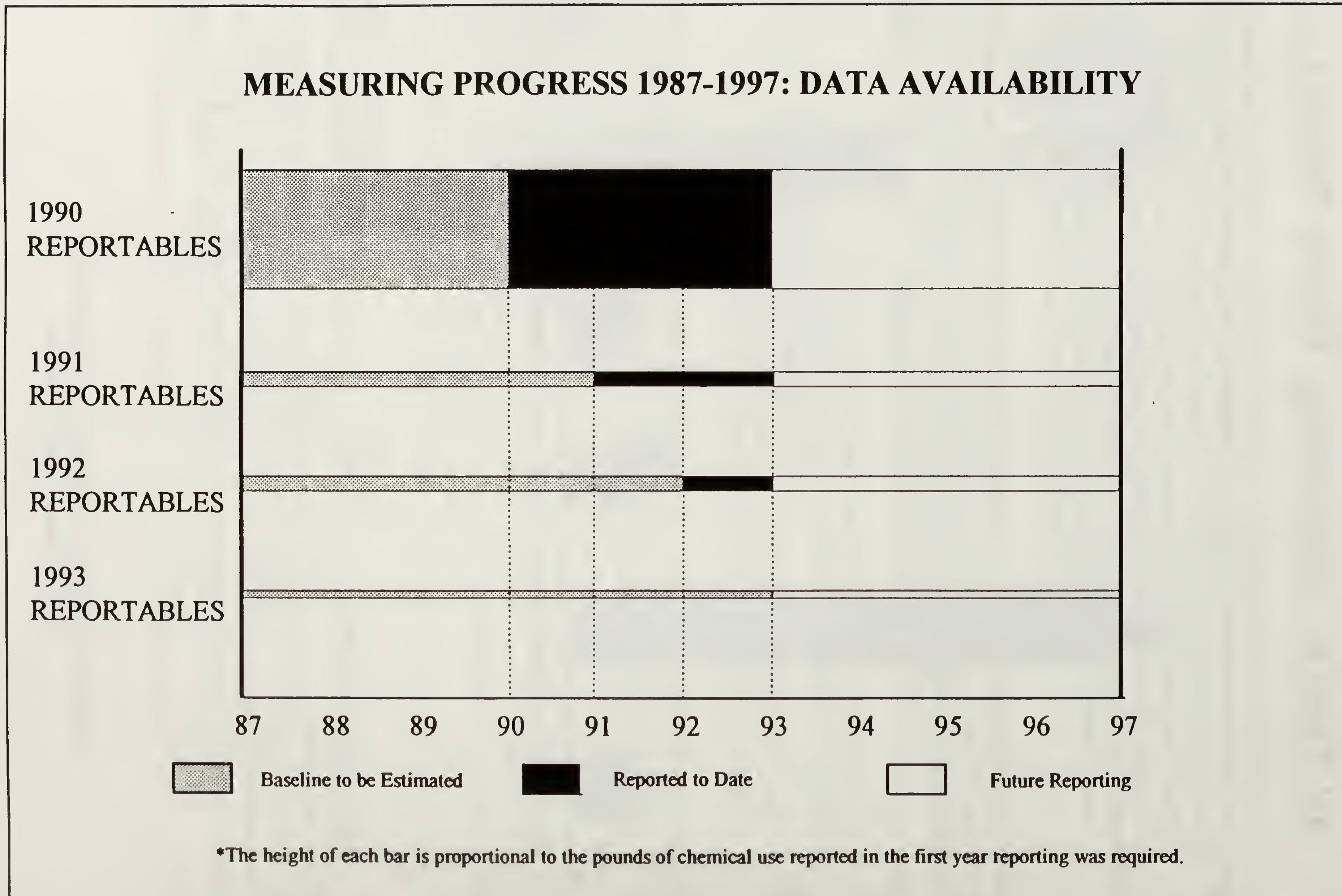

MEASURING PROGRESS 1987-1997: DATA AVAILABILITY
1990 REPORTABLES
1991 REPORTABLES
1992 REPORTABLES
1993 REPORTABLES
87
88
89
90
91
92
93
94
95
96
97
Baseline to be Estimated
Reported to Date
Future Reporting
*The height of each bar is proportional to the pounds of chemical use reported in the first year reporting was required.

Figure: 8-2

Total Chemical Amounts Reported For All Chemicals and Facilities Reporting on Form S
Universe: All TURA (All Quantities in Pounds)

Non-Trade Secret Amounts	1990	1991	1992	1993	% Reduction 90-93
Manufactured	25,806,774	15,257,099	20,405,477	19,862,748	+23.0
Processed	764,961,043	845,970,088	821,773,637	806,688,917	-5.5
Otherwise Used	136,380,491	151,644,838	191,439,678	188,488,448	-38.2
Total Use	927,148,308	1,012,872,025	1,033,618,792	1,015,040,113	-9.5
Generated Byproduct	114,214,580	135,144,852	144,588,903	137,052,977	-20.0
Shipped in/as product	329,044,771	453,459,967	432,253,186	483,678,133	-47.0
Releases & Transfers	36,222,140	55,187,355	59,190,876	54,695,117	-51.0

Trade Secret Amounts	1990	1991	1992	1993	% Reduction 90-93
Manufactured	100,658,715	127,736,507	88,017,207	74,493,372	+26.0
Processed	212,497,848	242,240,098	199,261,702	193,454,667	+9.0
Otherwise Used	1,222,302	10,721,274	4,820,922	5,904,030	-38.3
Total Use	314,378,865	380,697,879	292,099,831	273,852,069	+12.9
Generated Byproduct	8,567,796	16,502,460	13,082,538	16,509,676	-92.7
Shipped in/as prod.	108,544,853	157,467,467	111,473,106	107,081,883	+1.35
Releases & Transfers	4,209,826	11,346,493	5,555,383	6,122,964	-92.

Totals: Non-Trade Secret+Trade Secret	1990	1991	1992	1993	% Reduction 90-93
Manufactured	126,465,489	142,993,606	108,422,684	94,356,120	+25.4
Processed	977,458,891	1,088,210,186	1,021,035,339	1,000,143,584	-2.3
Otherwise Used	137,602,793	162,366,112	196,260,600	194,392,478	-41.3
Total Use	1,241,527,173	1,393,569,904	1,325,718,623	1,288,892,182	-3.8
Generated Byproduct	122,782,376	151,647,312	157,671,441	153,562,653	-25.0
Shipped in/as prod.	437,589,624	610,927,434	543,726,292	590,760,016	-35.0
Releases & Transfers	40,431,966	66,533,848	64,746,259	60,818,081	-50.4

Table 8-1 Total Chemical Amounts Reported for All TURA

- **All TURA with Trade Secret** - This universe includes all reported data for all years, all chemicals, and all facilities including information claimed trade secret. Only total quantities were provided by DEP for the trade secret information so this universe can only be studied on a gross level.

- **All TURA excluding Trade Secret** - The largest universe of data available for study in the extract files.[1] It includes all chemical records that were in the DEP extract files with the exception of duplicate key records (less than 3 million pounds in all years). This universe shows the total amount in the extract files but cannot be used for measuring progress because of the inconsistencies described in prior chapters such as trade secret inconsistencies.

- **Universe 0 - 1990 Reportables** - This universe includes records for any chemical and facility that would have been required to report in 1990, regardless of whether or not the facility actually reported the chemical in 1990. It includes only 1990 Reportables, i.e., EPCRA chemicals and manufacturing facilities. It is the largest *consistent* universe available for study in the extract files. It is used as the basis for most of the other universes reported on in this chapter.

- **Universe 1 - Complete Production Unit** - This universe is a subset of Universe 0. It includes only 1990 Reportable chemicals and facilities but excludes the quantities for any record that was incomplete (missing production unit (e.g., BRI) information). It was developed to measure progress for specific industries and for any analysis which requires production unit level information.

- **Universe 2 - Consistent Single Production Units** - This universe is a subset of Universe 1. It includes any 1990 Reportables for which the same chemical was used by a facility in only one production unit consistently over all four years. Where only one production unit is reported, the production unit BRI and ERI are the same as the facility-wide chemical BRI and ERI. These facility/chemical[2] records can be used to generate an aggregated BRI, which is a production normalized measure of progress. This universe contains 40% of the facilities reporting annually, one third of the total use, and 20% of the byproduct generated. Because of the small sample size and the sensitivity of the methodology to data errors and anomalies, this universe did not prove to be very useful for measuring progress with the existing TURA data. It may be more useful when data issues are resolved.

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[1]The chemicals claimed trade secret included 1990, 1991, and 1992 Reportables. Since the only information available about these chemicals was an aggregated total, it was not possible to analyze progress for these chemicals. Universe 0 was created, in part, by taking out records of chemicals that were reported in one year but claimed trade secret in subsequent years. This prevented the results from being skewed by inconsistent reporting. For example, if a facility reported 25 million pounds of a chemical in 1990 but claimed the chemical trade secret in 91-93, the extract file data would include only the 1990 data. This would give the appearance of a 25 million pound decrease from 1990 to 1991 when in fact it is unknown what actually happened.

[2]Facility/chemical indicates a given facility reporting on a particular chemical.

- **Universe 3 - Consistent Chemical** - This universe is a subset of Universe 0 and includes any 1990 Reportables where the same chemical was reported by a facility in every year from 1990 to 1993. This universe provides an understanding of the effect of changes in production units on facility chemical reporting. It also provides a universe where chemicals dropping below and rising above the threshold will not distort progress. The universe contains over 65% of the facilities reporting annually, and over 60% of the total use and byproduct generated.

- **Universe 4 - Consistent Facility** - This universe is a subset of Universe 0. It includes all 1990 Reportable chemicals reported by a facility that reported at least one 1990 Reportable chemical in all four years, 1990-1993. By only looking at facilities that reported consistently, this universe allowed testing whether facility movement into and out of the reporting universe affected the overall trends. This universe includes over 65% of the facilities annually reporting and over 80% of the total use and generated byproduct.

- **Universe 5 - 1990 to 1991 Year-to-Year Comparison** - This universe is a subset of Universe 0 and includes 1990 Reportables that were *actually* reported in both 1990 and 1991. Since it includes only records that were consistently reported in both 1990 and 1991, it provides a potentially more accurate indication of production normalized change from 1990 to 1991, by using a weighted average production ratio. It can only be used to measure change from 1990 to 1991.

- **Universe 6 - 1991 to 1992 Year-to-Year Comparison** - This universe includes all 1990 and 1991 Reportable chemicals and facilities that were *actually* reported in both 1991 and 1992. It provides a broader indication of change from 1991 to 1992 than Universe 0, by including 1991 Reportables. However, it can only be used to measure changes between 1991 and 1992.

- **Universe 7 - 1992 to 1993 Year-to-Year Comparisons**- This universe includes all 1990, 1991, and 1992 Reportable chemicals and facilities that were *actually* reported in both 1992 and 1993. It provides a broader indication of change from 1992 to 1993 by including 1990, 1991 and 1992 Reportables, but can only be used to measure changes between 1992 and 1993.

- **Universe 8 - 1991 Reportables** - Includes all the industries and chemicals first reportable in 1991. It provides a measure of the progress for these chemicals and industries from 1991 to 1993. It can only be used to measure progress from 1991 to 1993.

- **Universe 9 - 1992 Reportables** - Includes all chemicals first reportable in 1992. It provides a measure of the progress for these chemicals from 1992 to 1993. It can only be used to measure progress from 1992 to 1993.

Figure 8-3 shows a diagram of how these universes relate to each other. For a more complete description of what was included and excluded from each universe as well as the total quantities involved, see Appendix I. None of the numbered universes include records of any chemicals that were ever claimed trade secret by a facility.

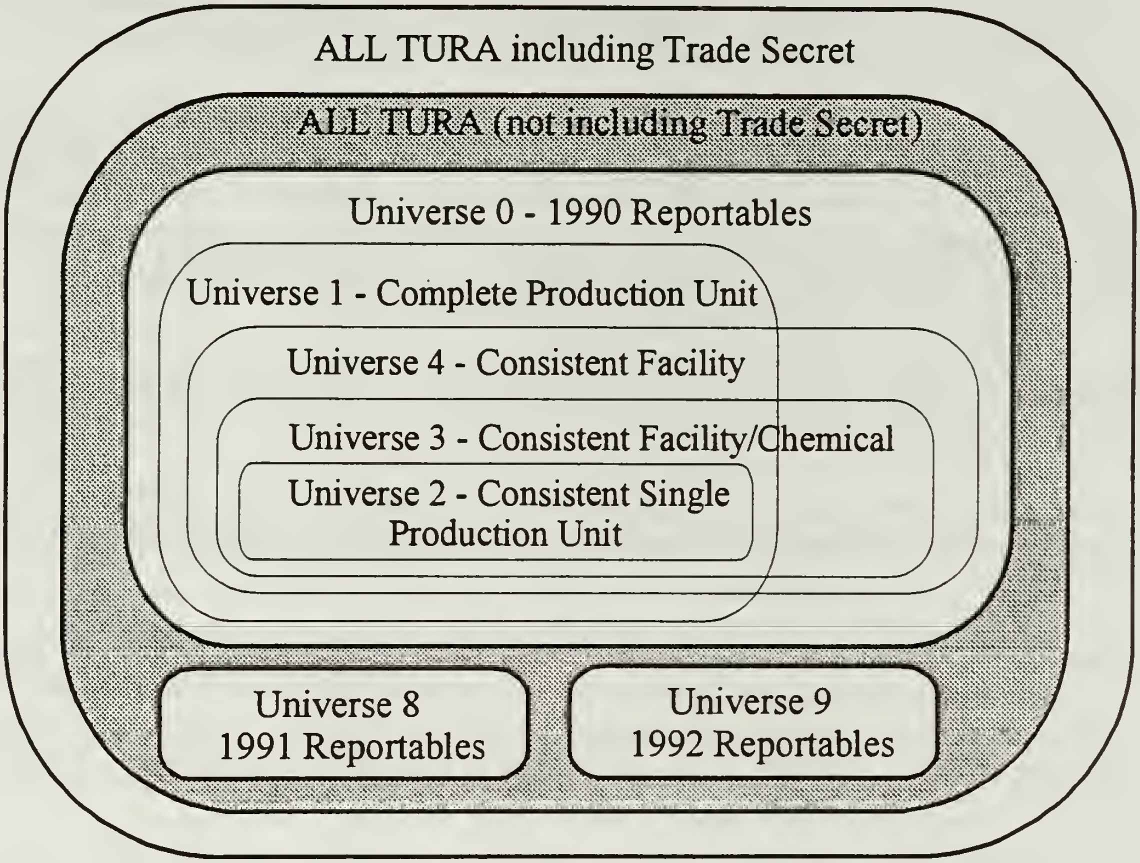

Figure 8-3 Relationships Between Specific Universes

Figures 8-4, 8-5 and 8-6 shows how the byproduct, total use[3], and TRI Releases and Transfers compare for several of these universes. All the shaded areas together represent the 'All TURA with Trade Secret' universe.

As seen in Figure 8-4, for all reported chemicals and facilities, byproduct increased by 25% from 1990 to 1993. However, the individual layers of the graph show why there was an increase. 1990 Reportable chemicals and facilities accounted for 93% of the reported byproduct in 1990. The byproducts for these chemicals and facilities actually declined by 12.5% from 1990 to 1993. The

[3] Total use is the sum of the amounts manufactured, processed and otherwise used.

apparent increase is due to the additional reportables added in 1991 through 1993. By 1993, the 1990 Reportables only accounted for 63% of all byproducts reported.

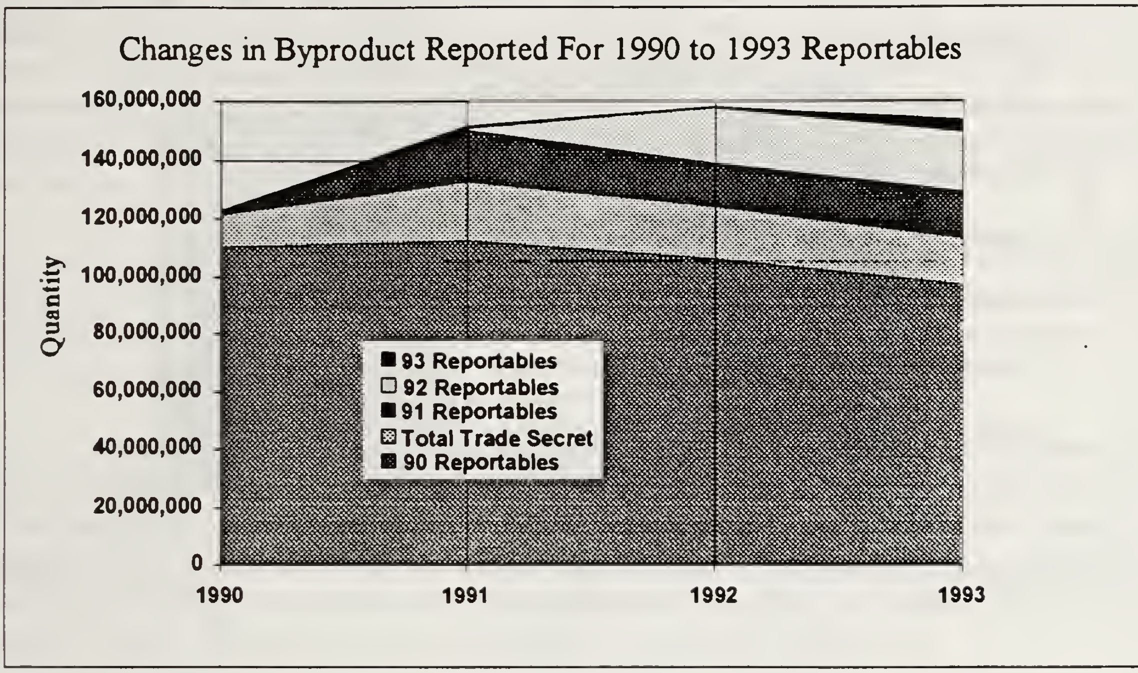

Figure 8-4

Total use, shown in Figure 8-5, also appears to increase because of changing reporting requirements. The quantity of total toxic chemical use reported by all TURA filers increased by 13% from 1990 to 1991 and then decreased slightly in 1992 and 1993. The overall change is a 4% increase from 1990 to 1993. However, the increase was due to added reportables in 1991 through 1993. The total use reported for the 1990 Reportable universe actually declined by 17% from 1990 to 1993[4]. It is the additional quantities due to expanded reporting requirements that cause the appearance of an increase.

TRI releases and transfers also increased by almost half from 1990 to 1993 although in this case there are two reasons for the increase. Some of the increase is due to the expanded list of facilities and chemicals in 1991 through 1993. The additional increase is due to the TRI reporting guidelines for off-site transfers, which changed in 1991 to include the reporting of more types of off-site transfers.[5]

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[4] Because no more detailed information is available for chemicals claimed trade secret, from this point on, all references to data excludes any chemicals that were ever claimed trade secret unless otherwise noted.

[5] In 1991, off-site transfers for energy recovery and recycling became reportable as "transfers to other off-site locations" under TRI. Because of this change, for the rest of this document, changes in TRI Releases and Transfers are measured from 1991 in order to keep the universe of reported quantities the same.

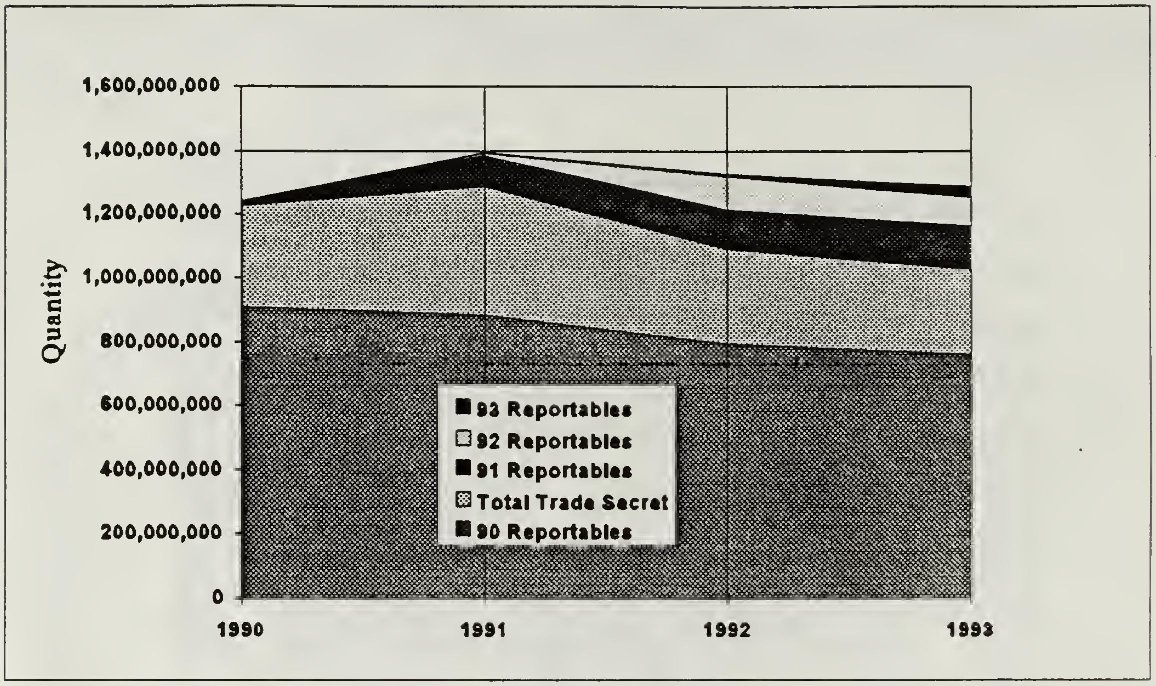


Figure 8-5

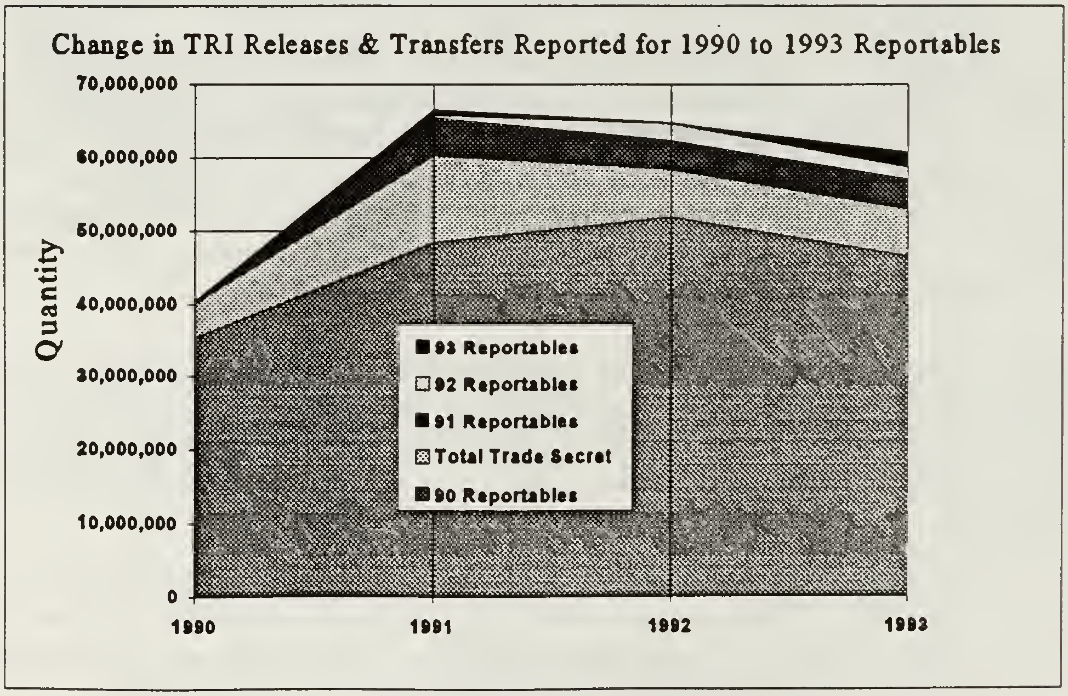


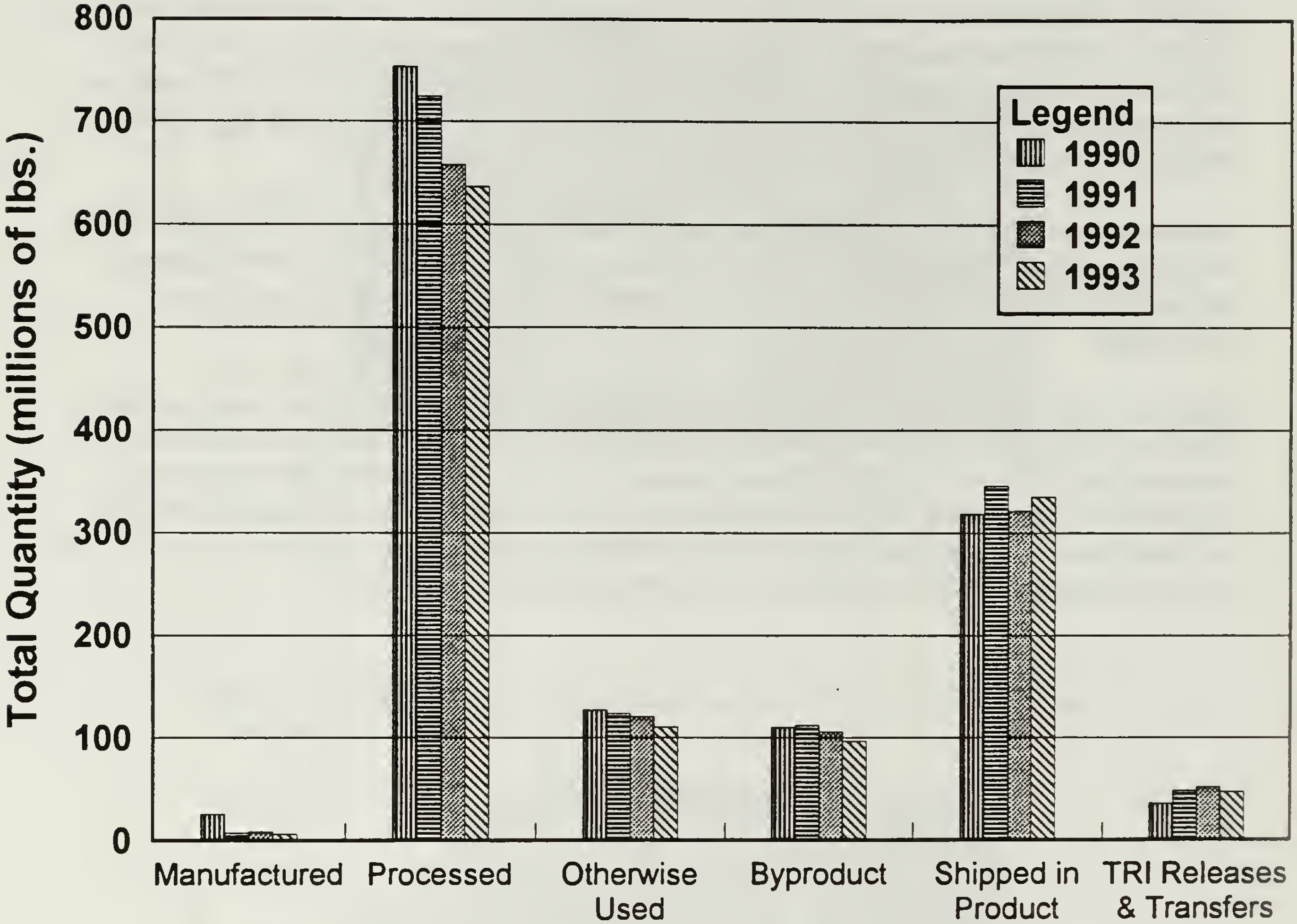
Figure 8-6

In 1990, the 1990 Reportables accounted for 90% of the byproduct generated (Figure 8-4), 73% of the quantity reported as used (manufactured, processed, or otherwise used) (Figure 8-5), and 88 % of the releases and transfers (Figure 8-6). Because more chemicals and facilities were required to report in later years, by 1993, the 1990 Reportables accounted for only 63% of byproduct, 59% of total use, and 77% of releases and transfers reported in 1993. The 1991 Reportables accounted for 10% of the byproduct and total use reported and 7%of the releases and transfers reported in 1993. The 1992 Reportables accounted for 13% of the byproduct, 7% of the total use, and 3% of the TRI releases and transfers reported in 1993.

Note that some facilities reported chemicals before they were required to, i.e., 1991 Reportables were reported in 1990, 1992 Reportables were reported in 1990 and 1991. These represent a very small fraction of the reported quantities and were not included in any of the progress calculations.

Figure 8-7 shows specific quantities reported for Universe 0. This is the largest consistent set of chemicals and industries available in the extract files. The observed trends are significantly different than those for 'All TURA' shown in Figure 8-1. Where Figure 8-1 showed almost all quantities increasing from 1990 to 1993, Figure 8-7 shows that, for the 1990 Reportables, with the exception of shipped in or as product and releases and transfers (see footnote 5, pg. 8-9), the quantities declined. Table 8-2 details the quantities represented in Figure 8-7.

1990 Reportables Universe 0



	Manufactured	Processed	Otherwise Used	Byproduct	Shipped in Product	TRI Releases & Transfers
1990	25.5	753.	127.	110.	318.	35.4
1991	7.44	724.	124.	112.	345.	48.4
1992	8.5	658.	121.	106.	321.	51.7
1993	6.32	637.	111.	97.	335.	46.6

Universe-0: 1990 Reportable Chemicals and SIC's, excluding Trade Secret data
Quantities in Millions of lbs.

Figure 8-7

Total Chemical Amounts Reported on Form S and R: Universe 0
1990 Reportable Chemicals and Facilities (all quantities in pounds)

TURA Information	1990	1991	1992	1993	% Reduction 90-93
Manufactured	25,531,959	7,444,207	8,500,285	6,322,692	+75.2
Processed	753,479,769	723,791,014	658,024,794	637,016,428	+15.4
Otherwise Used	126,948,628	124,461,342	121,074,364	111,014,677	+13.0
Total Use	905,960,356	855,696,563	787,599,443	754,353,797	+17.0
Generated Byproduct	110,369,343	112,328,998	105,833,339	96,552,630	+12.5
Shipped in/as product	318,173,895	344,760,629	320,858,622	334,632,394	-5.2

TRI Information	1990	1991	1992	1993	% Reduction 90-93
Total Releases	20,723,828	17,010,102	14,614,308	11,320,847	+45.4
Transfers to POTWs	3,188,173	1,708,104	1,864,793	1,479,757	+53.6
Other Transfers Off-site[6]	*11,486,742*	29,685,722	35,249,554	33,774,797	-13.8
Total Releases and Transfers[6]	*35,398,743*	48,403,928	51,728,655	46,575,401	3.8

General Information	1990	1991	1992	1993	% Reduction 90-93
Number of facilities	663	641	629	572	+13.7
Number of chemicals	110	109	110	101	+8.2
Number of records	1,985	1,933	1,898	1,697	+14.5

Table 8-2 Total Chemical Amounts Reported for 1990 Reportables

[6] Off-site transfers to energy recovery and recycling were not reportable until 1991. Therefore, the percent reduction is calculated from 1991 - 1993.

8.3 Normalization

Although the byproduct and other quantities for the 1990 Reportables showed a decrease, there is no indication of the reasons for the change. Changes could be due to changes in production or TUR efforts. To determine how much of the change is due to toxics use reduction, the quantities were normalized as described in the methodology section using a weighted average production ratio (PR_{wa}) calculated for a number of different universes. Table 8-3 shows the PR_{wa} for several of the universes for each of the years it was calculated. Note that the production ratio describes the change in production level from the previous year (e.g., 1991 PR represents the change from 1990 to 1991). As can be seen from Table 8-3, ~~reported~~ production levels declined from 1990 to 1992 and then increased from 1992 to 1993. By 1993, overall production levels were above the 1990 production levels in most universes. These PR_{wa} were used with the actual quantities reported to calculate an expected quantity (for byproduct, total use, etc.). Appendix I includes the PR_{wa} for all the universes as well as the percent of each universe's total use that was used to calculate the PR_{wa}.

	1991	1992	1993
1990 Reportables (Universe 0)	0.972	0.991	1.061
1991 Reportables (Universe 8)		0.945	1.108
1992 Reportables (Universe 9)			1.055
Reported in 1990 and 1991 (Universe 5)	0.972		
Reported in 1991 and 1992 (Universe 6)		0.987	
Reported in 1992 and 1993 (Universe 7)			1.065

Table 8-3 Weighted Average Production Ratios

Figure 8-8 shows the general format of the charts used in this report to present the results of the methodology. Each chart shows progress for a different quantity (byproduct, total use, etc.) For each quantity, the progress made by each group of reportable chemicals (1990 Reportables, 1991 Reportables, and 1992 Reportables) is shown is a separate line graph. The groups are shown separately to indicate that the quantities cannot be combined since there is no common baseline year from which to measure progress.

The general format of each graph is a line graph showing the actual and normalized change from the beginning year to the ending year. The solid (red) line represents the quantities actually reported for a particular universe. The dotted (blue) line represents the expected quantity calculated from the actual quantity and the PR_{wa}. The actual percent reduction is the difference between the quantity reported in the first year and the final year as a percent of the first year quantity. If the quantity reported in the final year is greater than the quantity reported in the first year, the result is negative. This indicates that there was an increase instead of a reduction in the reported quantity.

The normalized reduction is the difference between what was actually reported in the final year compared with what would have been expected in the final year based on changes in production level (PR_{wa}). This is the same as the percent avoided due to TUR. If the final year actual quantity is greater than the final year expected quantity, then the result is negative. In that case, instead of a percent avoided or percent normalized reduction, there is a normalized increase over expected quantities. The next section describes the results of these calculations shown in Figures 8-9 through 8-15.

8.4 Overall Progress - Actual and Normalized

8.4.1 1990, 1991 and 1992 Reportables

The largest subsets of the data for which progress can be measured are the 1990 Reportables (Universe 0), the 1991 Reportables (Universe 8), and the 1992 Reportables (Universe 9). Since there is only one year of data available for chemicals first required to be reported in 1993, those were not analyzed in this study.

As shown in Figure 8-9, the 1990 Reportables showed a reduction in byproduct generated. The byproduct reported declined from 110 million pounds in 1990 to 97 million pounds in 1993, a decrease of 13 million pounds. This is an actual reduction in byproduct of 13%. The byproduct for 1991 Reportables decreased by 2 million pounds, or 10%, from 17.6 million pounds in 1991 to 15.9 million pounds in 1993. Unlike the 1990 and 1991 Reportables, the 1992 Reportables showed an actual increase in byproduct generated of 2 million pounds or 7% from 1992 to 1993. Overall, the decrease of 1990 and 1991 Reportables outweighs the increase in 1992 Reportables for 1990 to 1993 progress.

Figure 8-9 also shows the results of normalizing the byproduct reported based on the weighted average production ratio for each of the universes. For the 1990 Reportables, there was a 14% normalized reduction in byproduct, that is, the byproduct avoided due to TUR was 16 million pounds. For the 1991 Reportables, the avoided byproduct was 2.6 million pounds, also 14%. The 1992 Reportables showed an increase in the byproduct of 0.5 million pounds more than the expected, a 2% increase[6]. Again, due to the relative magnitude of these three universes, the overall picture shows overall TUR progress in reducing byproduct from 1990 to 1993.

[6] As noted previously, the expected quantity is the amount reported in one year multiplied by the amount that the production level changed in the following year. If production goes up, reported quantities are expected to go up proportionately. If production goes down, reported quantities are expected to go down proportionately.

As seen in Figure 8-10, the 1990 Reportables also showed a reduction in total chemical use. The total use reported declined from 906 million pounds in 1990 to 754 million pounds in 1993, a decrease of 152 million pounds. This is an actual reduction of 17% for total chemical use. The 1991 Reportables increased by 30 million pounds, or 30%, from 101 million pounds in 1991 to 131 million pounds in 1993. The 1992 Reportables showed a reduction of 14 million pounds in total chemical use from 105 million pounds in 1992 to 91 million pounds in 1993, a 13% actual decrease in total use. Overall, the decrease of 1990 and 1992 Reportables outweighs the increase in 1991 Reportables for the 1990 to 1993 progress.

Figure 8-11 shows the change in the quantities shipped in or as product for the 1990, 1991, and 1992 Reportables. Unlike byproduct and total use, the amount of chemical reported shipped in product increased for all three groups of reportable chemicals. 1990 Reportables, which make up the majority of the chemicals reported shipped, showed an actual increase of 5% from 1990 to 1993. The 1991 and 1992 Reportables showed increases of 70% and 10% respectively, although the total quantity reported was much less than for the 1990 Reportables. Because the production levels increased from 1990 to 1993, the normalized increases were not as great, 3% for 1990 Reportables and 62% and 5% for 1991 and 1992 Reportables, respectively.

Figure 8-12 shows the change in TRI releases and transfers for the 1990, 1991 and 1992 Reportables. The method of reporting TRI transfers changed from 1990 to 1991 and resulted in a large increase in the quantity reported. In order to avoid misrepresenting the changes, the TRI releases and transfers were only measured from 1991 to 1993. The 1990 Reportables showed an actual decrease in releases and transfers of 2 million pounds or 4% from 1991 to 1993. The normalized percent avoided was 4 million pounds or 8%. The 1991 Reportables showed an actual decrease of 1 million pounds or 18% from 1991 to 1993. The normalized percent avoided was 22% or 1 million pounds. The 1992 Reportables showed an actual decrease of 0.5 million pounds or 23% from 1992 to 1993. This was a normalized decrease in expected transfers and releases of 26% or 0.6 million pounds.

Figures 8-13, 8-14, and 8-15 break down TRI releases and transfers to show the actual and normalized changes for TRI transfers to publicly owned treatment works (POTW), other transfers off-site, and releases to the environment. The 1990 Reportable transfers to POTWs and releases to the environment declined sharply from 1990 to 1993 with actual reductions of 54% for POTW transfers and 45% actual reductions of releases to the environment. When normalized for production levels, the results are 55% and 46% respectively. Other transfers off-site, however, increased significantly from 1991 to 1993. Actual increases for 1990, 1991 and 1992 Reportables were 14%, 17%, and 7%, respectively. Normalized increases for 1990, 1991 and 1992 Reportables were 8%, 11%, and 1%, respectively.

KEY TO FIGURES 8-9 to 8-15

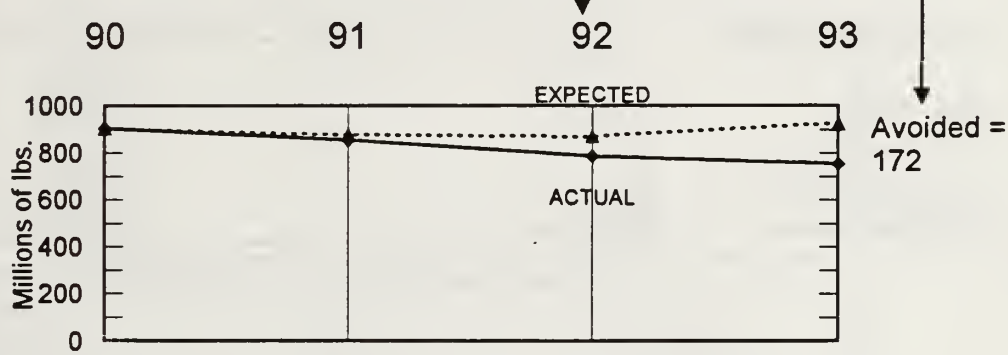
90 Reportables: Chemicals and industries required to report in 1990
(EPCRA chemicals and SIC 20-39) (Universe-0)
91 Reportables: Chemicals and industries added for 1991 reporting
(first third CERCLA chemicals and SIC 10-14, 40, 44-51, 72-73, 75-76) (Universe 8)
92 Reportables: Chemicals added for 1992 reporting
(second third CERCLA chemicals) (Universe 9)

Avoided = 93 Expected - 93 Actual (in millions of lbs.)
(+) values = less actual quantity than expected (indicates TUR)
(-) values = more actual quantity than expected (indicates more toxics use)

Reporting Year

90 Reportables

17% Actual Reduction
19% Normalized Reduction



	90	91	92	93
Actual	906	855	788	754
Expected	906	881	873	926

91 Expected = 90 Actual x 91 Production Ratio
92 Expected = 91 Expected x 92 Production Ratio
93 Expected = 92 Expected x 93 Production Ratio

Actual Reported Quantities

Actual % Change = $\frac{\text{90 (or first year) Actual - 93 Actual}}{\text{90 (or first year) Actual}}$

[in this example, total actual chemical quantity in 1993 was 17% less than in 1990]

Normalized % Change = $\frac{\text{93 Expected - 93 Actual}}{\text{93 Expected}}$

[in this example, there was a 19% reduction in total chemical quantity from what would have been expected in 1993, given changes in level of production]

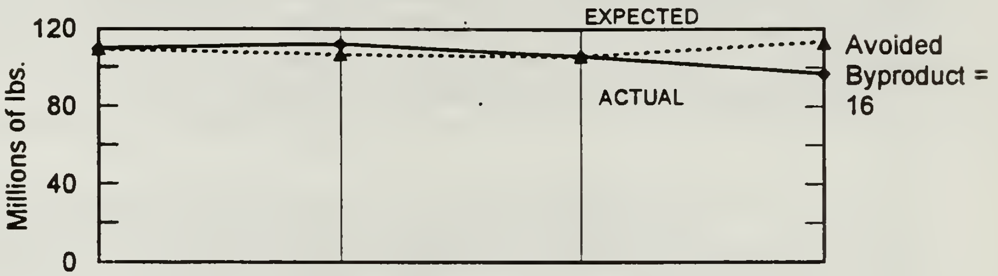
Figure 8-8

MA TURA
BYPRODUCT GENERATED

90 91 92 93

90 Reportables

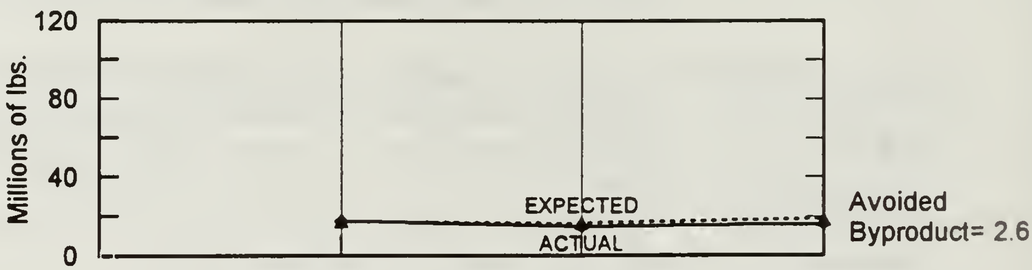
13% Actual Reduction
14% Normalized Reduction



	90	91	92	93
Actual	110	112	106	96.6
Expected	110	107	106	113

91 Reportables

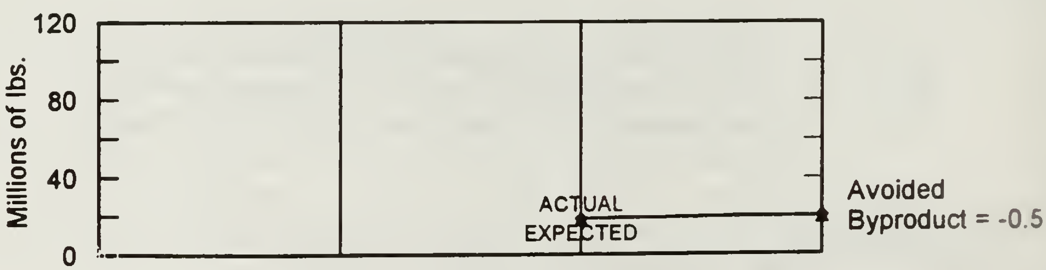
10% Actual Reduction
14% Normalized Reduction



	90	91	92	93
Actual		17.6	14.7	15.9
Expected		17.6	16.7	18.5

92 Reportables

8% Actual Increase
2% Normalized Increase



	90	91	92	93
Actual			18.8	20.3
Expected			18.8	19.8

90 91 92 93

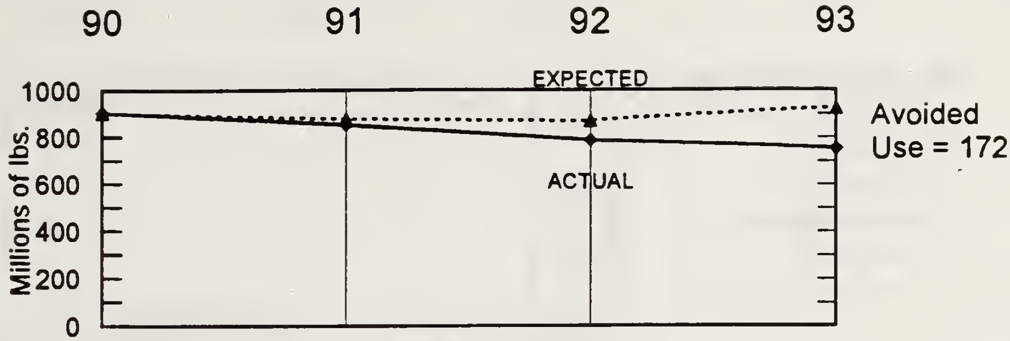
—◆— Actual Byproduct Quantity
---▲--- Expected Byproduct Quantity = Actual x Production Ratio
Avoided Byproduct = 93 Expected - 93 Actual

Figure 8-9

MA TURA
TOTAL USE

90 Reportables

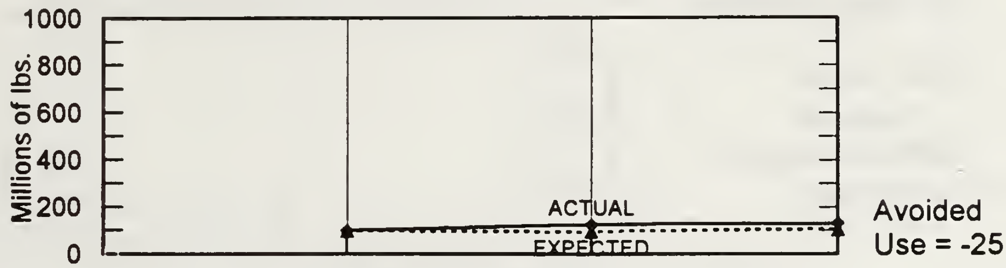
17% Actual Reduction
19% Normalized Reduction



	90	91	92	93
Actual	906	855	788	754
Expected	906	881	873	926

91 Reportables

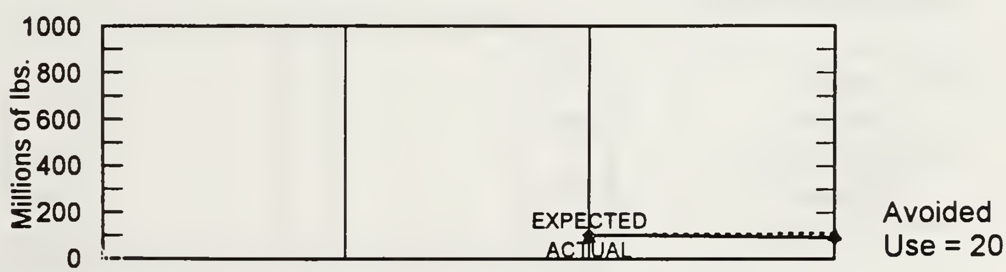
30% Actual Increase
24% Normalized Increase



	90	91	92	93
Actual		101	125	131
Expected		101	96	106

92 Reportables

13% Actual Reduction
18% Normalized Reduction



	90	91	92	93
Actual			105	91
Expected			105	111

90 91 92 93

Actual Total Use Quantity
Expected Total Use Quantity = Actual x Production Ratio
Avoided Use = 93 Expected - 93 Actual

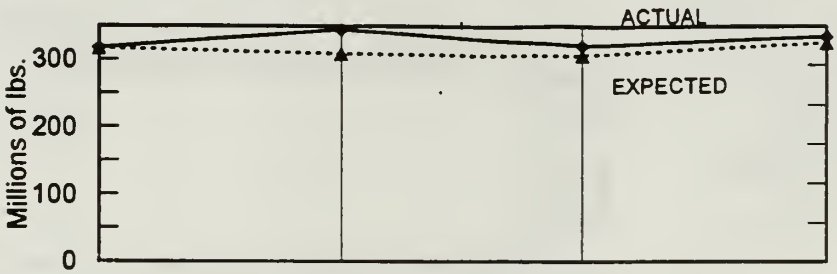
Figure 8-10

MA TURA
SHIPPED IN OR AS PRODUCT

90 91 92 93

90 Reportables

5% Actual Increase
3% Normalized Increase

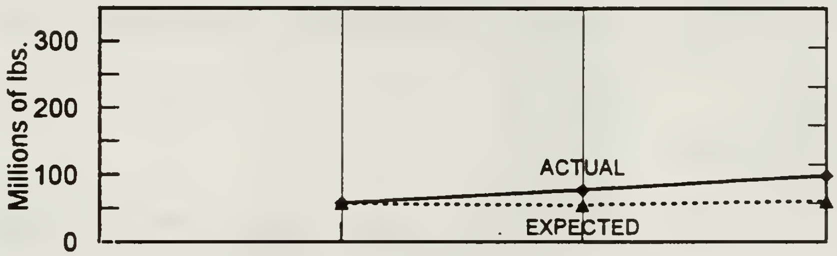


Avoided = -9.4

	90	91	92	93
Actual	318.2	344.8	320.9	334.6
Expected	318	309.3	306.5	325.2

91 Reportables

70% Actual Increase
62% Normalized Increase

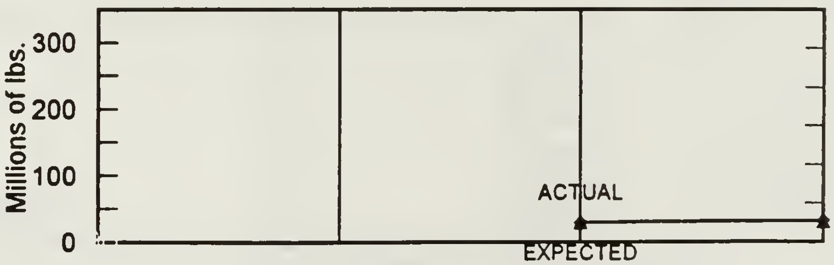


Avoided = -38.3

	90	91	92	93
Actual		58.9	78.4	100
Expected		58.9	55.7	61.7

92 Reportables

10% Actual Increase
5% Normalized Increase



Avoided = -1.5

	90	91	92	93
Actual			29.7	32.8
Expected			29.7	31.3

90 91 92 93

Actual Shipped in/as Product
Expected Shipped in/as Product = Actual x Production Ratio
Avoided Shipped in/as Product = 93 Expected - 93 Actual

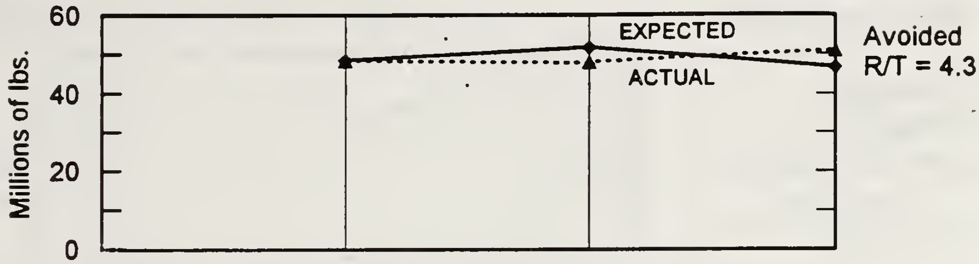
Figure 8-11

MA TURA
TRI RELEASES & TRANSFERS

90 91 92 93

90 Reportables

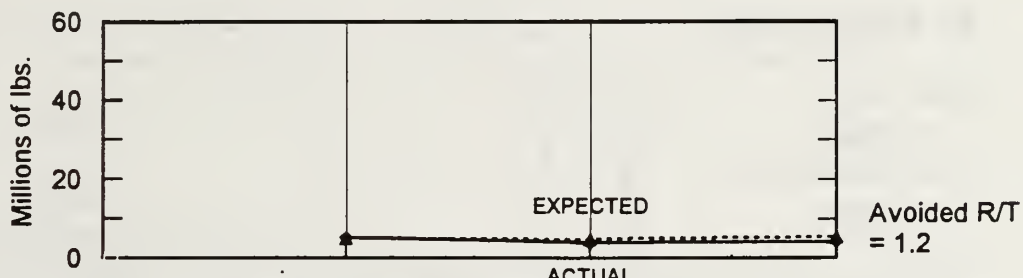
4% Actual Reduction
8% Normalized Reduction



	90	91	92	93
Actual		48.4	51.7	46.6
Expected		48.4	48	50.9

91 Reportables

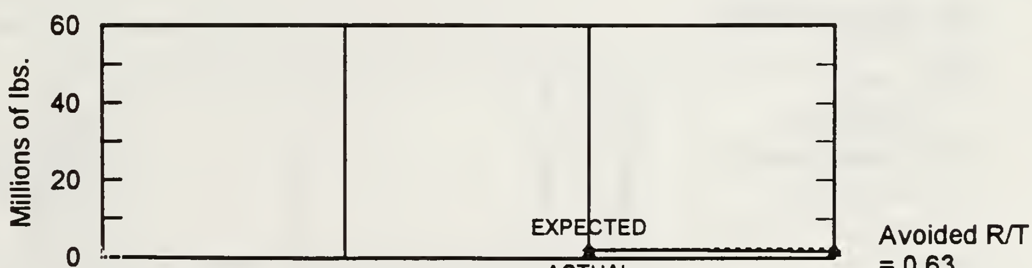
18% Actual Reduction
22% Normalized Reduction



	90	91	92	93
Actual		5.24	3.94	4.29
Expected		5.24	4.95	5.49

92 Reportables

23% Actual Reduction
27% Normalized Reduction



	90	91	92	93
Actual			2.24	1.73
Expected			2.24	2.36

90 91 92 93

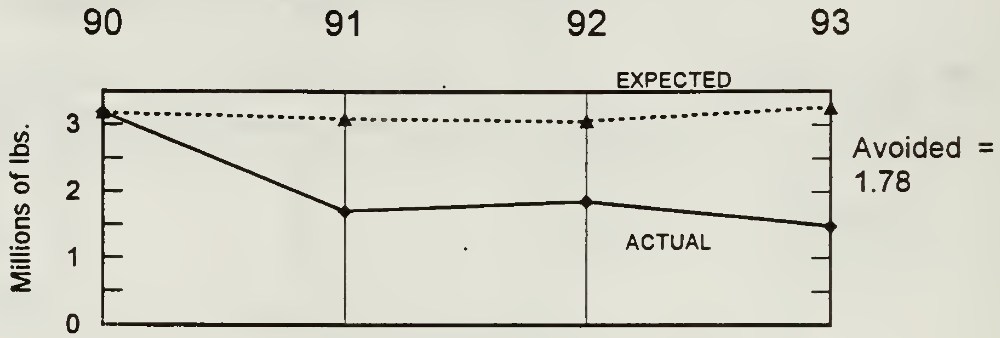
—◆— Actual TRI Releases and Transfers
---▲--- Expected TRI Releases and Transfers = Actual x Production Ratio
Avoided R/T = 93 Expected - 93 Actual

Figure 8-12

MA TURA
TRI TRANSFERS TO POTW's

90 Reportables

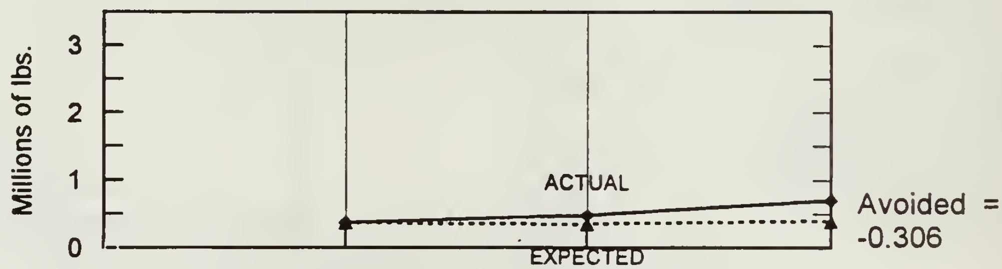
54% Actual Reduction
55% Normalized Reduction



	90	91	92	93
Actual	3.19	1.71	1.86	1.48
Expected	3.19	3.1	3.07	3.26

91 Reportables

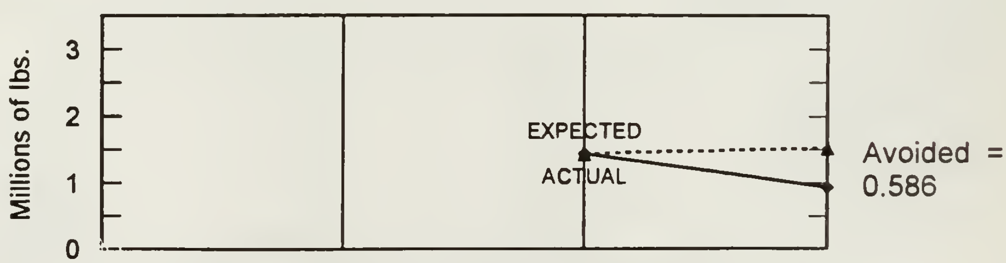
86% Actual Increase
77% Normalized Increase



	90	91	92	93
Actual		0.378	0.48	0.701
Expected		0.377	0.357	0.395

92 Reportables

35% Actual Reduction
39% Normalized Reduction



	90	91	92	93
Actual			1.44	0.933
Expected			1.44	1.52

90 91 92 93

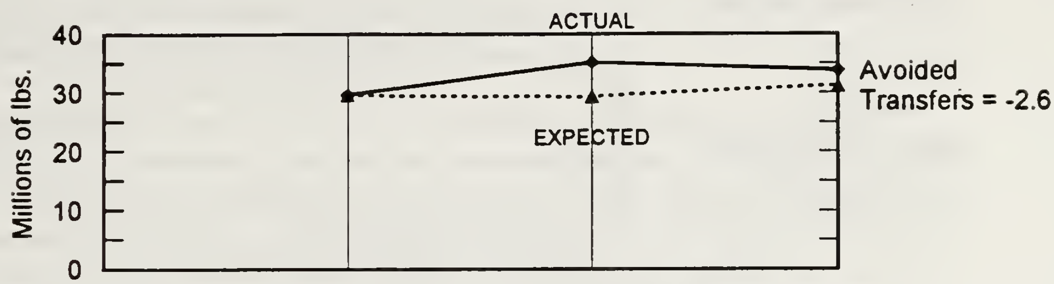
—◆— Actual TRI Transfers to POTW's
---▲--- Expected TRI Transfers to POTW's = Actual x Production Ratio
Avoided = 93 Expected - 93 Actual

Figure 8-13

MA TURA
TRI OFF-SITE TRANSFERS

90 Reportables

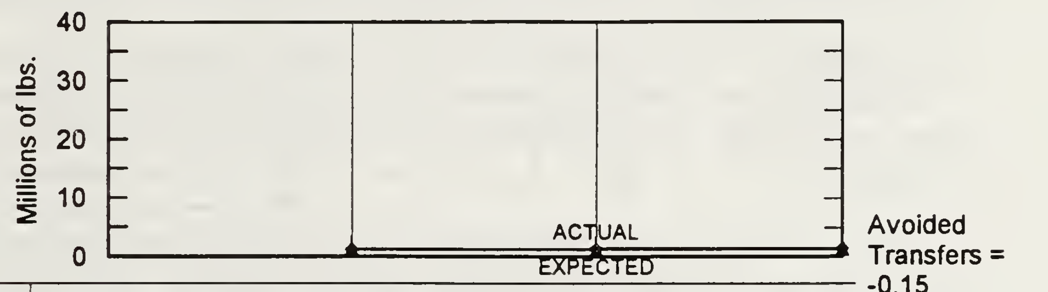
14% Actual Increase
8% Normalized Increase



	90	91	92	93
Actual		29.7	35.2	33.8
Expected		29.7	29.4	31.2

91 Reportables

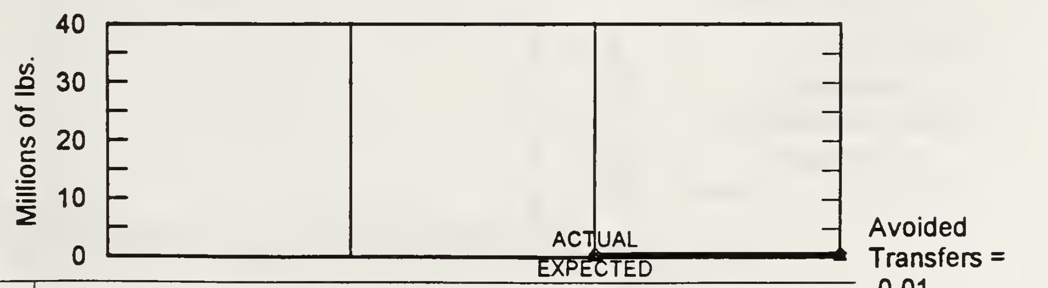
17% Actual Increase
11% Normalized Increase



	90	91	92	93
Actual		1.27	1.32	1.48
Expected		1.27	1.2	1.33

92 Reportables

7% Actual Increase
1% Normalized Increase



	90	91	92	93
Actual			0.66	0.7
Expected			0.66	0.69

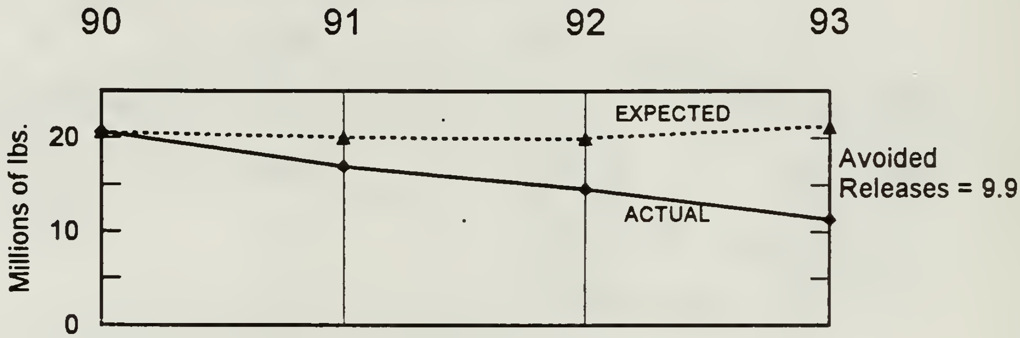
Actual Off-site Transfers Quantity
Expected Off-site Transfers Quantity = Actual x Production Ratio
Avoided = 93 Expected - 93 Actual

Figure 8-14

MA TURA
TRI RELEASES TO ENVIRONMENT

90 Reportables

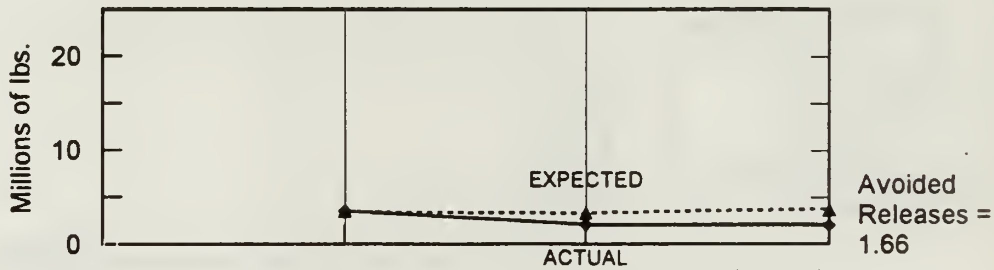
45% Actual
Reduction
46% Normalized
Reduction



	90	91	92	93
Actual	20.7	17	14.6	11.3
Expected	20.7	20.1	20	21.2

91 Reportables

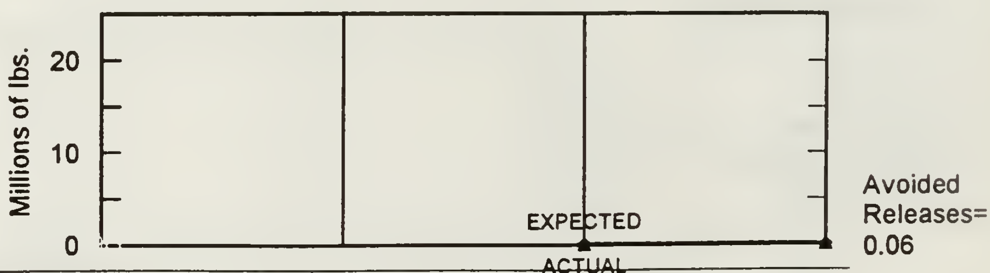
41% Actual
Reduction
44% Normalized
Reduction



	90	91	92	93
Actual		3.59	2.14	2.1
Expected		3.59	3.39	3.76

92 Reportables

34% Actual
Reduction
37% Normalized
Reduction



	90	91	92	93
Actual			0.14	0.09
Expected			0.14	0.15

90 91 92 93

Actual TRI Releases to the Environment
Expected TRI Releases to the Environment = Actual x Production Ratio
Avoided Releases = 93 Expected - 93 Actual

Figure 8-15

8.4.2 Year to Year Change

The preceding eight figures, Figures 8-8 through 8-15, demonstrate one method for measuring progress for a constantly changing group of facilities and chemicals, based on the year that reporting was first required. For each universe, the charts in figures 8-9 to 8-15 show progress from the first year that reporting was required through 1993.

The next set of figures demonstrate a second method for measuring progress for constantly changing groups of facilities and chemicals. This method measures progress from one year to the next and includes in the measurement all the facilities and chemicals that actually reported in both years. Figure 8-16 is a sample of how to interpret the following three charts. Each chart shows progress for three different two year intervals: 1990-1991, 1991-1992, and 1992-1993. The first section on each chart is for chemicals that facilities reported in *both* 1990 and 1991 (Universe 5). The second section on each chart is for chemicals that facilities reported in *both* 1991 and 1992 (Universe 6). The third section is for chemicals that facilities reported in *both* 1992 and 1993 (Universe 7). Because each year-to-year comparison has a different baseline, the percent reductions cannot be mathematically combined into one percent change for 1990 to 1993.

Figure 8-17 through 8-19 show changes in quantities from year-to-year for byproduct, total use, and TRI releases and transfers. Byproduct (Figure 8-17) remained constant from 1990 to 1991 but then had 7% and 4% decreases in actual byproduct reported in 1992 and 1993. The normalized byproduct reduction from 1992 to 1993 was 10%.

The total use (Figure 8-18) showed a continuous decrease from 1990 to 1993, both for actual and normalized quantities reported. Changes in releases and transfers were calculated using 1991 as the starting year because of changes in the reporting requirements. From 1991 to 1992, combined releases and transfers (Figure 8-19) increase, both actual quantities and quantities normalized for production. From 1992 to 1993, however, releases and transfers had a decrease of 9% actual and 15% normalized.

KEY TO FIGURES 8-17 to 8-19

TOTAL QUANTITY - YEAR TO YEAR CHANGE

Universes 5, 6 and 7
Chemicals and Facilities reporting over two year periods
Excluding Trade Secret

Avoided Quanitity: When expected quantity (blue dashed line) is greater than actual quantity (red solid line) in the second year, the difference is equal to the avoided quantity due to TUR, and represents a normalized measure of progress. The larger the difference between the two, the greater the amount of normalized progress

Universe 7 - All facility/chemical combinations reported in both 1992 and 1993
By definition, includes 90, 91 and 92 Reportable chemicals and industries

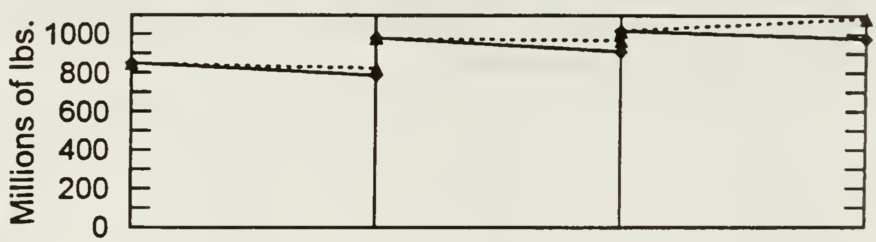
Universe 6 - Same as above for 1991 and 1992
By definition, includes only 90 and 91 Reportable chemicals and industries

Universe 5 - Same as above for 1990 and 1991
By definition, includes only 90 Reportable chemicals and industries

e.g., $\frac{\text{91 Actual - 90 Actual}}{\text{90 Actual}}$ → Actual Change

e.g., $\frac{\text{91 Expected - 91 Actual}}{\text{91 Expected}}$ → Normalized Change

	90 - 91	91 - 92	92 - 93
Actual Change	7%	7%	4%
Normalized Change	5%	6%	10%



Total quantity reported for Universe as stated above → Actual

Expected Quantity, e.g., 91 Expected = 90 Actual x P.R. (P.R. = TRI Production Ratio) → Expected

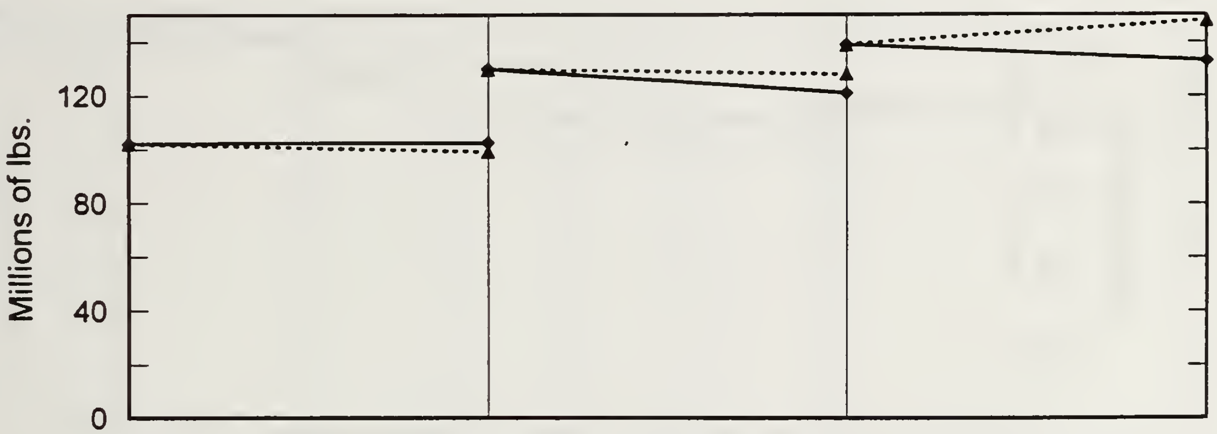
	90	91	92	93
Actual	852	790		
Expected	852	828		
Actual		984	912	
Expected		984	971	
Actual			1018	978
Expected			1018	1084

Figure 8-16

BYPRODUCT - YEAR TO YEAR CHANGE

Universes 5, 6 and 7
Chemicals and Facilities reporting over two year periods
Excluding Trade Secret

	90 - 91	91 - 92	92 - 93
Actual Change	**0%**	**7%**	**4%**
Normalized Change	**-3%**	**6%**	**10%**



	90	91	92	93
Actual	102.3	102.6		
Expected	102.3	99.4		
Actual		130	121	
Expected		130	128.3	
Actual			139	133
Expected			139	148

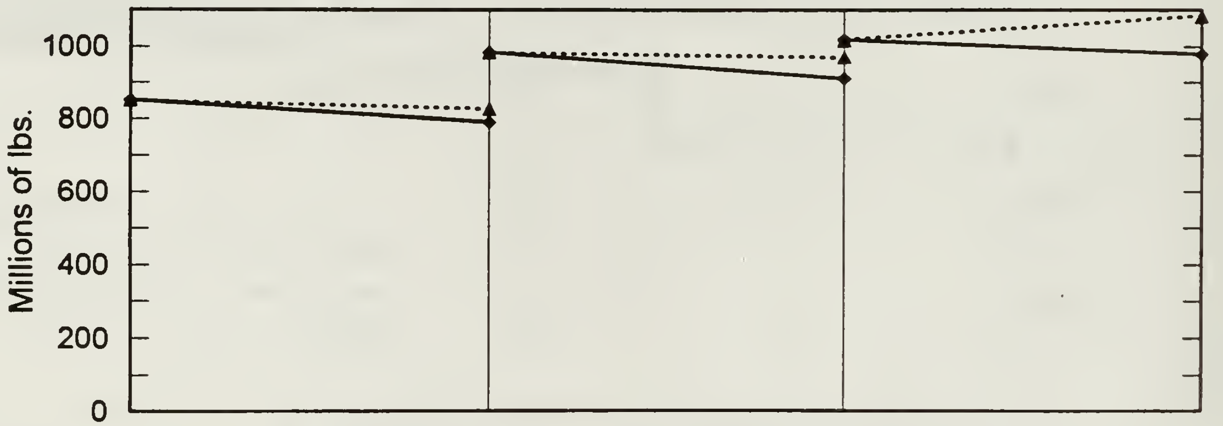
Actual Byproduct Quantity
Expected Byproduct Quantity = Actual x Production Ratio

Figure 8-17

TOTAL USE - YEAR TO YEAR CHANGE

Universes 5, 6 and 7
Chemicals and Facilities reporting over two year periods
Excluding Trade Secret

	90 - 91	91 - 92	92 - 93
Actual Change	**7%**	**7%**	**4%**
Normalized Change	**5%**	**6%**	**10%**



	90	91	92	93
Actual	852	790		
Expected	852	828		
Actual		984	912	
Expected		984	971	
Actual			1018	978
Expected			1018	1084

Actual Total Use Quantity
Expected Total Use Quantity = Actual x Production Ratio

Figure 8-18

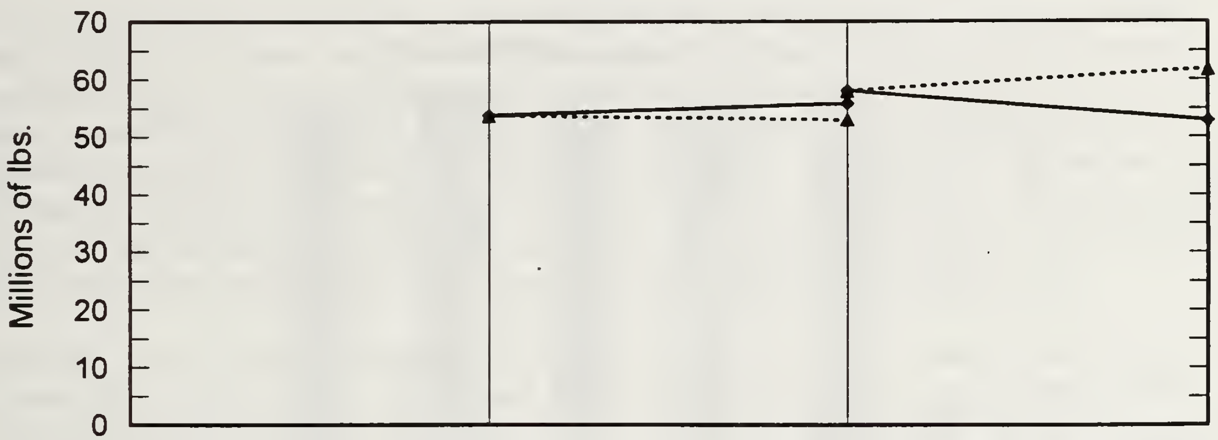
TRI RELEASES & TRANSFERS
- YEAR TO YEAR CHANGE

Universes 5, 6 and 7

Chemicals and Facilities reporting over two year periods

Excluding Trade Secret

	90 - 91	91 - 92	92 - 93
Actual Change		**-4%**	**9%**
Normalized Change		**-5%**	**15%**



	90	91	92	93
Actual				
Expected				
Actual		53.7	55.8	
Expected		53.7	53	
Actual			58	52.8
Expected			58	61.8

Actual Releases and Transfers Quantity

Expected Releases and Transfers Quantity = Actual x Production Ratio

Figure 8-19

8.5 Progress of Selected Facility Universes

8.5.1 Top 20 and Non-Top 20 Use Facilities

Statewide progress in TUR can also be viewed in terms of the progress made by different groups of facilities. A large percentage of the reported chemical byproduct and use in Massachusetts is from a small number of facilities. Because the relative amount of byproduct and use reported every year by different facilities changes, there is no static list of the top ten or top twenty users of chemicals in Massachusetts. However, over the four years for which data is available, there are only 28 facilities that have been one of the top twenty users in any of the four years. These facilities are referred to in this report as the "Top 20 Use Facilities." The "20" refers to the fact that they were in the list of top 20 total use facilities for at least one year, not the number of facilities in the list. "Non-Top 20 Use Facilities" refers to all those facilities that did not report enough total use to be on the top 20 use facility list for any year.

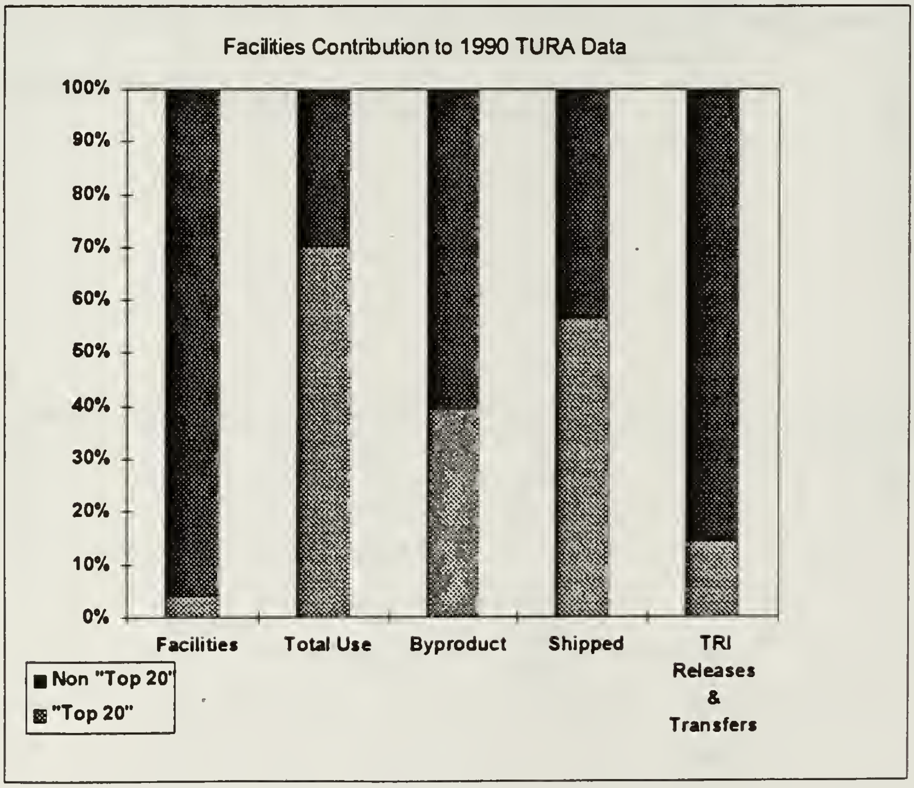


Figure 8-20

Figure 8-20 shows how these facilities and their reported quantities compare to the reported quantities for all other facilities. Although the top 20 use facilities comprise less than 4% of the facilities reporting in any given year, they account for almost 70% of the total use reported in all years, 40% of the byproduct generated and 50% of the toxic chemicals shipped in product.

According to the TRI production ratios, there were significant differences in production level trends for these two groups of facilities. Table 8-4 shows the weighted average production ratio for each group and for Universe 0 overall. The top 20 use facilities reported a slight decline in production for 1991 and 1992 followed by a 6% production increase in 1993. The non-top 20 use facilities showed a steady increase in production ranging from 4% to almost 8% each year.

Weighted Average Production Ratios	91	92	93
Universe 0 - All 1990 Reportables	0.972	0.991	1.061
Universe 0 - Top 20 Use Facilities	0.948	0.955	1.062
Universe 0 - Non Top 20 Use Facilities	1.040	1.077	1.061

Table 8-4 Top 20 and Non-Top 20 Weighted Average Production Ratios

There is also a different pattern in the reported byproduct for these two groups. As previously seen in Figure 8-20, the non-top 20 use facilities accounted for a larger portion of the reported byproduct. Figure 8-21 shows that they also experienced a larger actual reduction, 15% or 10 million pounds from 1990 to 1993.[7] The top 20 use facilities experienced an actual byproduct reduction of only 9% or 3 million pounds during that same time. Because of the differences in the reported production ratios for each group, the normalized byproduct differences are greater. The non-top 20 use facilities avoided 22 million pounds or 28% of expected 1993 byproduct while the top 20 use facilities avoided only 2 million pounds or 5% of expected 1993 byproduct.

In contrast, the top 20 use facilities accounted for almost all of the actual reduction in total use reported. Their actual reduction in total use of 148 million pounds, 23%, from 1990 to 1993, accounted for most of the overall reduction in total use of 152 million pounds seen in Universe 0 as shown in Figure 8-22. The 4 million pounds of actual reduction achieved by the rest of the facilities was only a 2% reduction from their 1990 actual reported total use. The normalized results are closer because the top 20 use facilities reported lower production ratios than the rest of the facilities over most of the reporting period. On a normalized basis, the top 20 use facilities avoided 124 million pounds or 20% of total expected chemical use and the non-top 20 use facilities avoided 54 million pounds or 17% of total expected chemical use.

[7] The next three graphs use a format similar to that seen in Figures 8-9 to 8-15. The quantities actually reported are represented by a solid line, the quantities normalized for production (the 'expected' quantities) are represented by dashed lines. The quantities reported by all three groups (top 20 and non-top 20 use facilities as well as the total 1990 Reportables--Universe 0), are given on each graph to allow comparison between the groups. If the dashed line is higher than the solid line, there was a normalized *reduction* in the quantity shown. If the solid line is above the dashed line, actual quantities were greater than the expected quantities so there was a normalized *increase*.

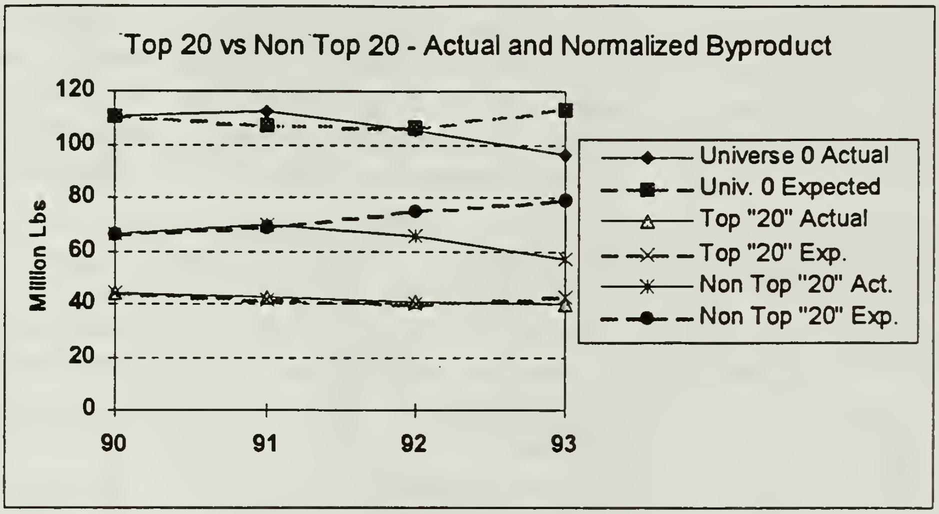


Figure 8-21

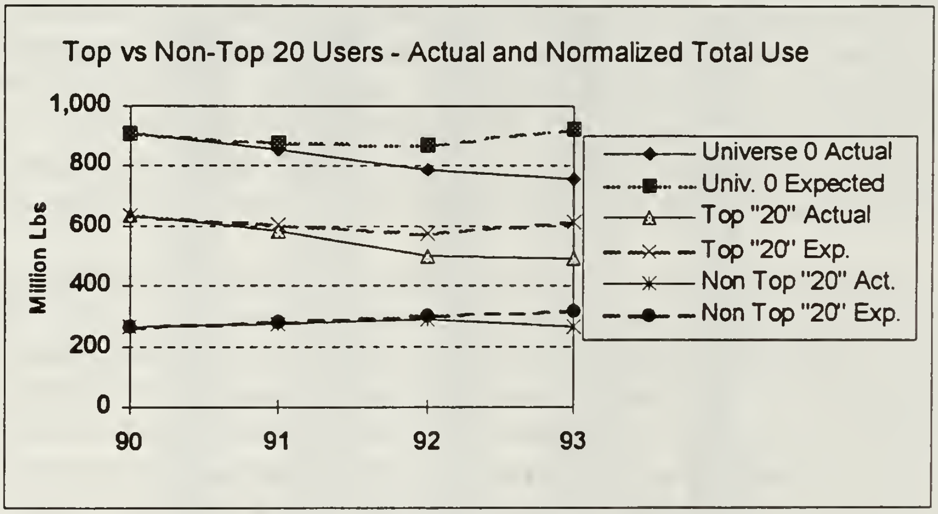


Figure 8-22

The amount of chemicals reported shipped in product follows yet a different pattern (Figure 8-23). The actual amount shipped for all 1990 Reportables increased by 16 million pounds from 1990 to 1993, an increase of 5%. Most of this was due to increases in the amount shipped by the non-top 20 use facilities. For all facilities, the actual quantity shipped was very close to the expected amount shipped. This indicates that changes in quantities of toxic chemicals shipped in or as product are primarily due to changes in production levels, rather than TUR.

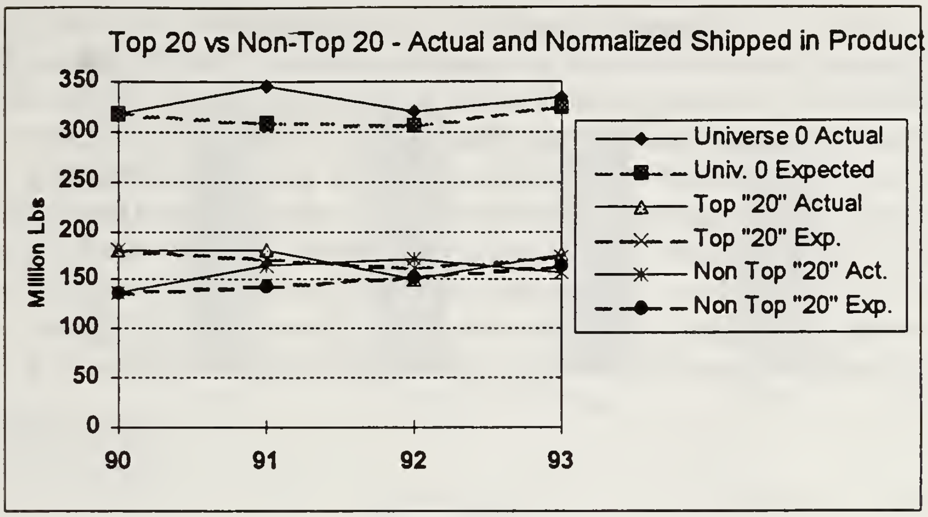


Figure 8-23

8.5.2 Facilities and Chemicals Going Below and Above Threshold

As discussed in Chapter 7, one issue with measuring progress is that facilities can stop reporting for a number of reasons including: reducing the use of toxics below the reporting threshold, substituting a non-reportable chemical for a listed toxic chemical, or reducing production for economic or market reasons. Some of these reasons represent TUR activities, while others do not. Because they are no longer reported, it is not possible to determine what the actual reductions are.

Universes 3 and 4 are two subsets of Universe 0 which can be used to analyze the effect of dropping below or rising above the reporting threshold on the overall measurement of TUR progress.

Universe 4, Consistent Facility, includes records for any chemicals reported by a *facility* that reported at least one chemical in *all four years*. If a facility reported in all four years, then all their 1990 reportable chemicals are included, including those that dropped below or came above the reporting threshold during that time. Universe 3, Consistent Chemical, is a subset of Universe 4 and includes only records for *chemicals* that were reported by a facility for *all four years*.

The next two graphs show how these two universes compare to Universe 0. In each graph, the bar for each year represents the total number or quantity reported for Universe 0. The two lines represent the number or quantity for Universes 3 and 4. Because Universe 3 is a subset of Universe 4, Universe 3 is always the lower line in the graph.

Figure 8-24 shows how the byproduct generated compares between these three universes; similarly, Figure 8-25 shows how total use quantities compare. In all four years, the consistent facilities (Universe 4) were responsible for more than 91% of the total Universe 0 byproduct and 93% of the total Universe 0 use reported. The difference between Universe 4 and Universe 0 byproduct quantities consists of facilities coming into and going out of reporting. Consistent chemicals (Universe 3) included between 80% and 86% of the Universe 0 byproduct and 86% of the Universe 0 total use reported.[8] The difference between Universe 3 and Universe 4 byproduct quantities consists of chemicals, used by consistent facilities, which fell below or rose above the reporting threshold. Similarly, the difference between Universe 3 and Universe 0 consists of all chemicals which fell below or rose above the reporting threshold during the four year period.

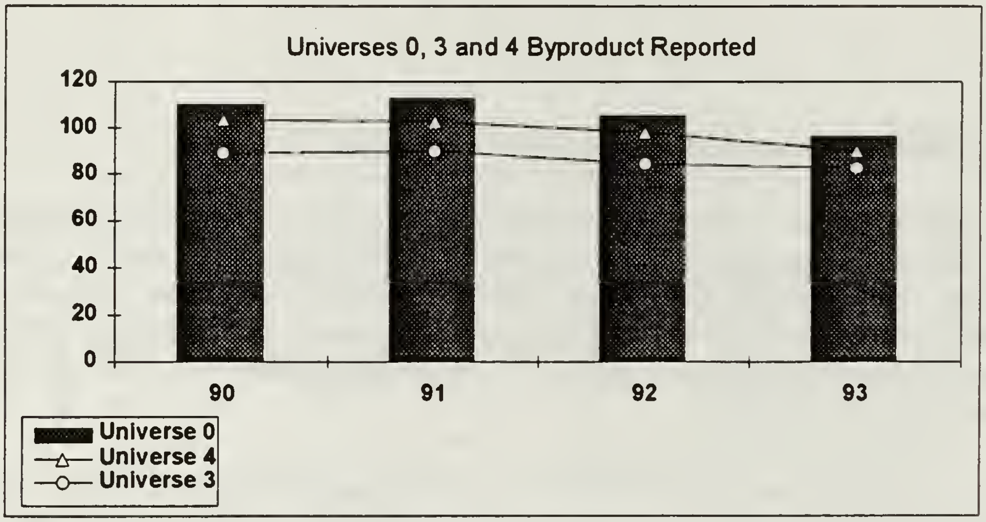


Figure 8-24

[8]Note that the number of facilities reporting in Universe 0 dropped from 663 in 1990 to 572 in 1994 (see Appendix J1), while the number of facilities reporting in Universes 3 and 4 remained constant at 421 and 446, respectively. This indicates a trend of more facilities dropping below thresholds than coming above.

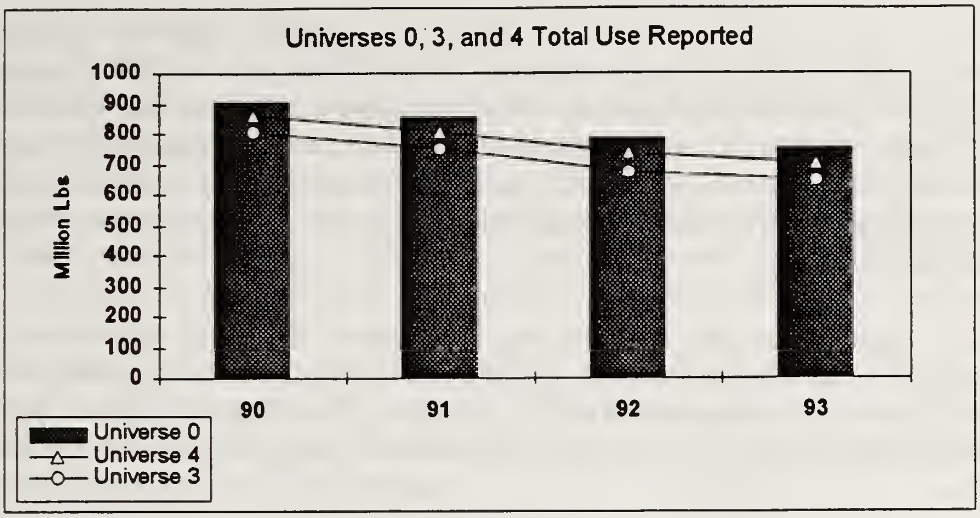


Figure 8-25

Figure 8-26 compares the actual percent reductions and normalized percent reductions of Universes 0, 3, and 4. For byproduct, Universe 3 experienced a reduction in actual quantity of byproduct generated of 8% over four years, while both Universes 4 and 0 experienced a 13% reduction. It is possible, therefore, that the problem of chemicals falling below or rising above the threshold, causing a 'quantum' jump of ± 10,000 lb or 25,000 lb (the threshold amounts), could cause an overstatement of progress by as much as 5%. The actual reduction depends on the actual quantities of byproduct generated in years prior to and after reporting years, but is at least 8% and possibly as high as 13%. Results also indicate that overall byproduct reduction trends are similar (13%) for facilities which report consistently and all facilities reporting during the four year period.

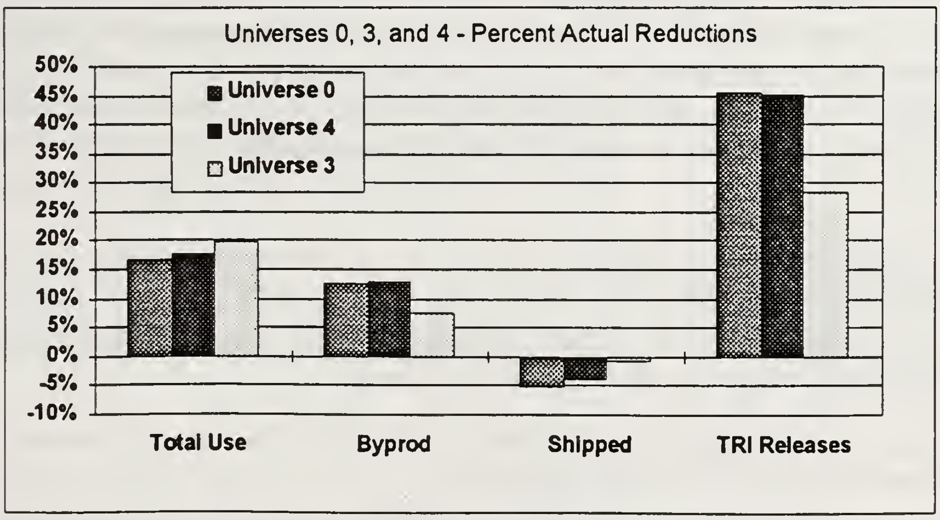


Figure 8-26

The pattern for TRI releases to the environment are similar but more marked. Universe 3 experienced a reduction in actual quantity of TRI releases of 28% over four years, while both Universes 4 and 0 experienced a 45% reduction. Therefore, the overstatement of progress in releases to the environment could be as high as 17%. These results indicate clearly that chemicals leaving the reporting universe are responsible for a large portion of the progress in releases to the environment for Universe 0.[9]

The trends for total use are different. Universe 3 (consistent chemicals) experienced a reduction in total use quantity of 20% over four years, Universe 4 (consistent facilities) experienced an 18% reduction, and Universe 0 experienced a 17% reduction. Therefore, chemicals falling below or rising above the threshold may cause an *understatement* of progress in total use reduction by as much as 3%.

This analysis suggests that the effect of facilities leaving and entering the reporting universe do not have a significant effect on the measurement of progress, while the effect of chemicals dropping below and rising above the reporting threshold may be significant. For byproduct and total use, overstatement or understatement of progress was shown to be less than 5% over 4 years. For releases to the environment, the effect could be as high as 17% of 1990 releases. The lack of chemical quantity data for years in which the chemicals were not reported result in uncertainty in the measurement of progress. In each instance, this uncertainty is approximately one third of the actual quantity change.[10]

8.6 Further Analysis of TUR Progress

In addition to measuring state-wide progress, an attempt was made to analyze progress for smaller subsets of the reporting universe such as individual chemicals, groups of facilities and chemicals, and different industry segments. Because of the data issues[11] described in Chapter 4 and the sensitivity of the small subsets to data anomalies, these analyses did not lead to definitive results. However, the preliminary results suggest that the methodology will be useful in measuring progress in different areas once the data issues are resolved. This section describes some of the subsets that were reviewed and the problems that were encountered.

[9] The quantities referred to here are only for releases to the environment. Transfers off-site are not included because of changes in reporting requirements discussed in Section 8.2

[10] For byproduct, 5% is approximately one third of 13%. For releases to the environment, 17% is approximately one third of the actual quantity change of 45%.

[11] Many of the subsets involve small numbers of facilities or chemicals. In these cases, missing or invalid information has a more significant effect on the methodology.

8.6.1 Analysis by Chemical Group

The quantities reported for several categories of chemicals were analyzed for TUR progress. These categories were selected because they were of particular concern or because the chemicals in the category could be expected to exhibit similar TUR trends. The chemicals included in each category are listed in Appendix B. Several data issues discussed previously in Chapter 4 were encountered when the methodology was applied to these categories. Briefly, the chemical categories studied and the problems with applying the methodology to those categories included:

- Acids - the four chemicals in the list were subject to the problem of inconsistent reporting of wastewater treatment chemicals. Also, in many cases these chemicals may have been consumed in the production process. The TURA data format does not allow these factors to be taken into account in the methodology.

- Carcinogens - one chemical, styrene monomer, accounted for the vast majority of the reported quantities in this category. Because of this, the results were reflective of styrene, not carcinogens in general.

- EPA 33/50 chemicals - this category included some metals and so was subject to the problems described below for metals. Also, a number of reporting anomalies were identified that needed further investigation before the results could be presented with confidence.

- Metals - the metals used in the largest quantities, particularly copper, were subject to the problem of inconsistent reporting of metal bender exemption chemicals. Also, facilities are instructed to use the total weight of a metal compound when reporting use and the weight of just the metal portion of the compound when reporting byproduct. There also appeared to be problems with facilities reporting these numbers incorrectly in the initial reporting years.

- Montreal Protocol chemicals[12] - a number of these chemicals were not reportable until 1991 and therefore were not included in the analysis. The 1990 Reportable chemicals in this group exhibited over 60 % reduction for byproduct and total use in both actual and normalized terms. TRI releases to the environment for this group were reduced by over 80 %. This trend is the result of federal environmental regulations which phase-out production of these ozone-depleting chemicals for emissive uses as of January 1996.

- Swedish Chemical list - this category included metals and so was subject to the problems described previously. Also, a number of reporting anomalies were identified that needed further investigation before the results could be presented with confidence.

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[12] Montreal Protocol chemicals are those Class I ozone-depleting substances being phased-out under international treaty (Montreal Protocol) and federal regulations (Clean Air Act Amendments of 1990).

The primary benefit of testing the methodology with these groups was that a number of reporting and data issues were identified. When these issues are resolved, analysis by chemical group should provide an insight into which types of chemicals are responsible for overall observed changes. A sample analysis by chemical group for Montreal Protocol chemicals is included in Appendix J3.

8.6.2 Analysis by How Chemicals are Used

Chemical use is reported under TURA in three different-categories: manufactured, processed, and otherwise used. As seen in Figure 8-27, 79% of the total chemical use reported is chemicals processed in the production of product. Only 10% of the total 1990 reported total use in Massachusetts was due to chemicals manufactured and 11% was due to chemicals otherwise used.

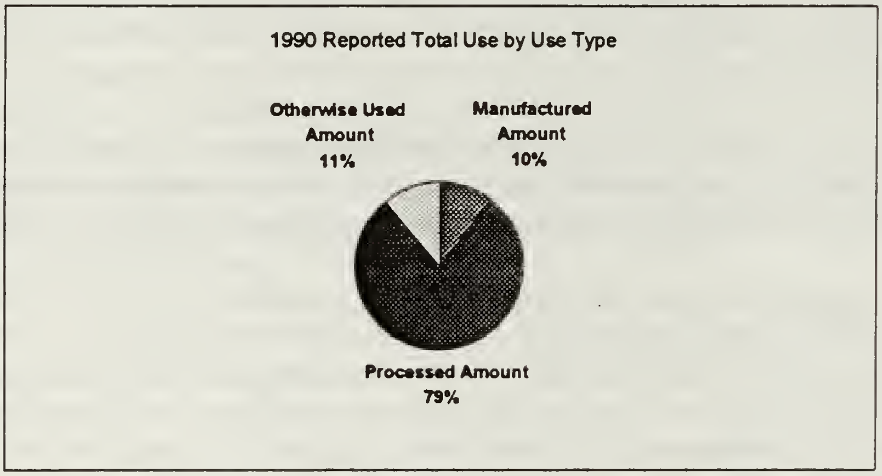

Figure 8-27

In general, these different uses produce different end points for the chemicals. Chemicals that are manufactured or processed tend to have a larger percentage of the chemical shipped as product and a smaller percent generated as byproduct. Chemicals that are otherwise used end up largely as byproduct, rather than shipped in product. The TUR techniques applicable to each type of use are different, as well as the ease of implementing them. For example, input substitution for copper is not likely to be appropriate if you are a supplier of copper plating baths. In addition, if the toxic chemical is a critical component in your product formulation, input substitution will require more research and testing than if the chemical is otherwise used and not critical to your final product. For these reasons, differences in TUR trends may appear depending on how the chemical is used.

Therefore, an analysis was performed based on a preliminary categorization of selected chemicals into groups based on how they were typically being used. Chemicals were separated based on whether they were generally manufactured, processed or otherwise used. As for the previous chemical groups, many issues were discovered during these analyses.

One issue related to trade secret claims within different use types. As seen in Figure 8-28, 80% of the chemicals manufactured in Massachusetts were claimed trade secret in 1990. The remaining subset of manufactured chemicals was too small for progress to be meaningfully measured.

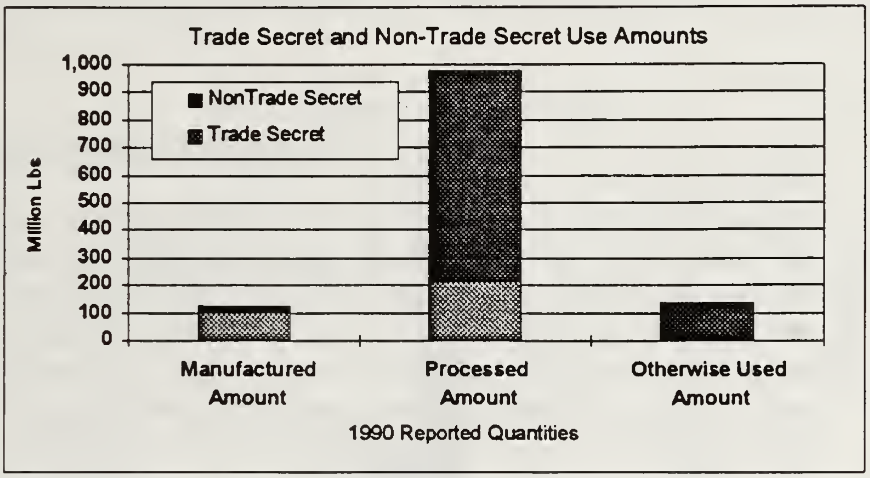

Figure 8-28

Conversely, only 22% of the processed chemicals and 3% of the otherwise used chemicals were claimed trade secret. These two use types provided a large enough sample size for analysis. Initially, an attempt was made to group chemicals into those processed and those otherwise used. One problem with this classification scheme was that, for the group of chemicals that were mainly processed, styrene monomer accounted for 53% of the reported byproduct and 89% of the reported use. The results of the methodology were heavily influence by the styrene data. In order to account for this effect, a second group of 'processed' chemicals was created that excluded styrene.

Another problem with this classification scheme was that, although there were a number of chemicals that were mainly processed, there were no chemicals that, as a whole, were mainly otherwise used. It was found that for a chemical that had large amounts reported as otherwise used, there were some facilities that mainly otherwise used the chemical and some facilities that mainly processed it. The solution was to group the chemicals into three groups: chemicals including styrene that were processed in large quantities, chemicals excluding styrene that were processed in large quantities, and chemicals that were both processed and otherwise used.[13] The list of chemicals included in each category is included in Appendix B.

Figure 8-29 shows the relative amounts reported manufactured, processed and otherwise used for those three groups of chemicals. As can be seen from the figure, the 'processed' chemical group had a very small amount reported as manufactured or otherwise used. However, for the 'processed and otherwise used' chemical group, the quantities processed and otherwise used were almost equal.

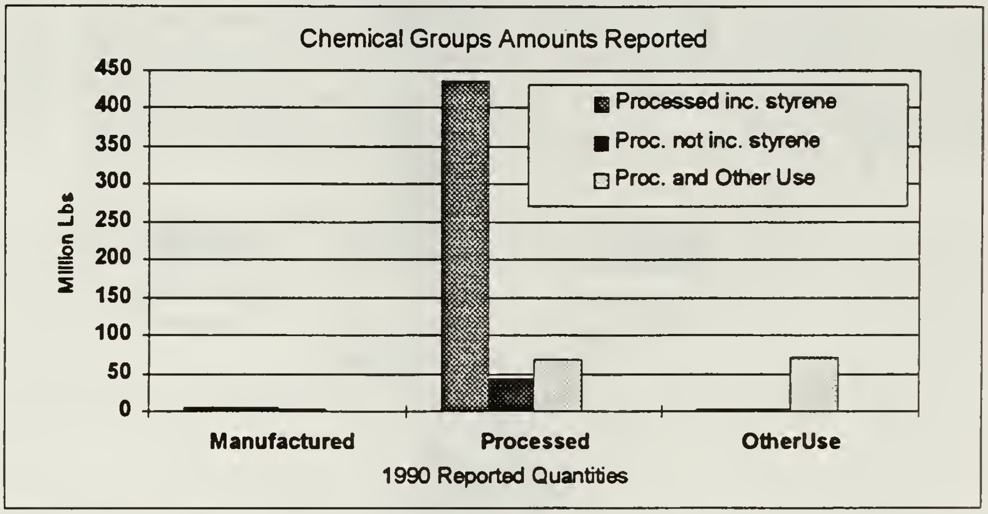

Figure 8-29

These groups of chemicals also had different changes in levels of production as measured by the weighted average production ratio (PR_{wa}). In particular, because styrene comprised such a large percent of the quantities reported for processed chemicals, it was the determining factor for normalizing production levels for the entire group. In general, 'processed chemicals with styrene' showed a net decrease in production over the four year period, while the 'processed chemicals without styrene' showed an increase. 'Processed and otherwise used' production ratios also suggested an increase over the four year period. (see Appendix J-3)

This methodology for grouping chemicals by how they are used was tested; the results are included in Appendix J-3. This preliminary analysis suggests the following:

- styrene has an overpowering effect on any group that it is in, therefore, the group should be analyzed both with and without styrene,

[13]The criteria for grouping chemicals, although not done rigorously, was based on the total use reported, the proportion of the use reported as processed versus otherwise used, and the number of facilities that reported each chemical. In general, chemicals were selected for the 'processed' category if the amount processed was greater than 10 million pounds and accounted for more than 80% of the total use. Chemicals were selected for the 'otherwise used' category if the amount otherwise used was over 2 million pounds and accounted for at least 40% of the total use.

- chemicals that are mostly processed appear to have greater progress in reducing byproduct generated than chemicals that are processed and otherwise used, and
- chemicals that are processed and otherwise used appear to have decreased total use and releases to the environment more than chemicals that are processed.

Analysis by chemical group offers valuable insight into the reasons for TUR progress. Analyses such as the ones described in this section will be explored further when the next data release becomes available.

8.6.3 Analysis by Industry SIC groups

The analysis of industry SIC groups was done by grouping facility data according to reported SIC codes. The analysis was performed using both the facility-level SIC codes developed (Section 3.3.3.2) as well as the production unit-level SIC codes reported on Form S. These two analyses were compared to determine if trends were markedly different between the two and to check the degree of "double counting" in the production unit-level analysis.[14] The SIC codes were grouped using the draft proposed TURA User Segment categories. (see Appendix C)

As with the analysis of chemical groups, the issues with the data having to do with small sample sizes and data anomalies do not allow results to be presented here with confidence. However, the preliminary results suggest that there are differences in TUR progress made by different industries. A sample industry SIC code analysis is included in Appendix J-4.

8.7 Summary

In summary, the methodology appears to work for large sets of data but is sensitive to data anomalies and errors with smaller sets (less than 50% of the data). Massachusetts facilities appear to be making progress in reducing the generation of toxic byproducts although the amount of progress varies between different segments of the reporting universe. Tables 8-5 and 8-6 summarize the progress for a few of the major universes reviewed in this study. Further study is needed once the existing data issues have been resolved, in order to obtain a more accurate measure of TUR progress for facilities in Massachusetts.

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[14] Double counting occurs because the same facility-wide quantity is attributed to each primary production unit-level SIC code. If one chemical is used in several production units with different SIC codes, it will be 'counted,' or included, in each analysis.

TURA DATA - 1990 REPORTABLES

	Quantity	1990 (lbs)	1991 (lbs)	1993 (lbs)	Change (lbs) [90 or 91 to 93]	Actual % Reduction	Normalized % Reduction
TURA	Byproduct	110,369,343		96,552,630	13,816,713	13%	14%
	Manufactured	25,531,959		6,322,692	19,209,267	75%	
	Processed	753,479,769		637,016,428	116,463,341	15%	
	Otherwise Used	126,948,628		111,014,677	15,933,951	13%	
	Total Use	905,960,356		754,353,797	151,606,559	17%	-8%
	Shipped in or as Product	318,173,895		334,632,394	(16,458,499)	-5%	-3%
TRI	Total Releases	20,723,828		11,320,847	9,402,981	45%	46%
	Transfers to POTWs	3,188,173		1,479,757	1,708,416	54%	55%
	Other Transfers Off-Site		29,685,722	33,774,797	(4,089,075)	-14%	-8%
	Total Releases & Transfers		48,403,928	46,575,401	1,828,527	4%	8%

Table 8-5 Actual and Normalized Progress for TURA 1990 Reportables

Universe	Percent Reductions 1990 to 1993			
	Byproduct		Total Use	
	Actual	Normalized	Actual	Normalized
1990 Reportables (Universe 0)	13%	14%	17%	19%
Consistent Facilities (Universe 4)	13%	13%	18%	20%
Consistent Chemicals (Universe 3)	8%	8%	20%	20%
Top 20 Use Facilities	9%	5%	23%	20%
Non Top 20 Use Facilities	15%	28%	2%	17%
Montreal Protocol Chemicals	74%	73%	68%	67%

Table 8-6 Actual and Normalized Progress for Selected Universes

9 CONCLUSIONS AND RECOMMENDATION

9.1 Conclusions

9.1.1 Methodology

A methodology was developed for measuring TUR progress in Massachusetts using the TURA and TRI data. The methodology takes the following approach:

- **Consistent Universes** To make data comparable across years, subsets of the full database, or 'universes', must be created which have consistent reporting requirements and which are free of other inconsistencies (e.g., trade secret data or production unit information) at the particular level being studied. This approach led to the formation of multiple universes, each with a different consistent data set which could be analyzed for trends.

- **Multiple Metrics** Measuring TUR progress is a very complex undertaking. Changes in chemical use and byproduct generation patterns, which are the result of many diverse activities and influences, must be identified and quantified. Using multiple metrics of progress results in a more robust methodology, where different metrics incorporate different types of activities and influences. If the different metrics independently suggest the same conclusions, then there will be a much higher level of confidence in the result. Additionally, multiple metrics will suggest reasons for observed overall trends.

- **Actual and Production Normalized Measures** Actual measures analyze changes in the reported quantities, regardless of the reason for change. Production Normalized measures attempt to factor out changes in quantities due to changes in production levels, leaving only changes resulting from TUR activities. This methodology used a weighted average TRI Production Ratio as a proxy for production level.

The methodology was applied to the 1990 - 1993 TURA data, both to test the methodology and to provide an indication of TUR progress in the Commonwealth. The methodology appeared to work well at the state-wide level for large universes. However, it was sensitive to data anomalies and errors for small subsets, such as those created for industry or chemical level analysis. Because some facilities have a disproportionately large percent of chemical use or byproduct, or because some subsets may only include a few facilities, data anomalies will always have the potential to distort progress for small subsets. However, this effect will be lessened by improving the data quality further.

Between one third and one half of the records available for study are single-production unit-chemicals, the only type of records for which production unit-level BRI's can be aggregated to produce an overall state-wide BRI. This subset proved to be sensitive to data anomalies and errors, in part because of its size and in part because of the large number of data anomalies and errors at the production unit level. Changing production unit numbers and changing base years also limit the number of cases where the methodology can be applied.

9.1.2 Data Quality

Several sources of data quality problems were identified, including facility reporting errors, data entry errors, database system problems and data extract procedure problems. Both facility reporting and data entry errors were concentrated in 1990 reporting year. Facilities were contacted about questionable data; approximately one half of the responses from those facilities have been received. Data entry errors were corrected in FMF and will be included in the next data release. System and extract procedure problems were analyzed to determine the best solution, and a schedule has been created for working on them. Some, but not all, will be included in the next data release.

What is the effect of data quality on the measurement of progress? The facility reality check found that facility-level quantities had a reasonably low error rate, while six of the eleven facilities had some type of production unit information errors. This suggests that errors in toxic chemical quantities are unlikely to significantly effect the measurement of progress at the state-wide level. For smaller subsets of data, however, data anomalies and errors may distort progress. The errors in production unit-level information cause difficulties in analyzing the data. For example, between 4 and 6 percent of the data cannot be used for analyzing industry-level progress because of incomplete records. Therefore, the primary impact on measuring progress is at the chemical or industry level, rather than at the state-wide level, and on analyses which use production unit-level data.

9.1.3 Reality Check

The check of specific facilities to validate the methodology provided a great deal of useful information and insight into the problems and issues that face TURA filers.

Facility managers often indicated that they had low confidence in their production unit level information. This is due to four factors. The first is that facility managers find it difficult to identify good normalizing measures for the BRI calculations. The second is that problems with changing production unit numbers makes it difficult to maintain reliable production unit level data. The third factor relates to facilities using standard emission factors or other similar estimation techniques. TUR activities are not incorporated into emission factors, therefore, byproduct estimates based on these factors do not change as TUR is implemented. The last factor applies to facilities with small quantities of byproduct. When total quantity of byproduct is very small, unimportant, small changes in quantity of byproduct may translate into large percent changes, either positive or negative.

Generally speaking, the eleven 'reality check' facilities have made significant improvements in TURA data collection and analysis since 1989. These improvements range from better measurements of byproducts and emissions (as opposed to estimates) to better inventory control procedures to employee training. The most important trend is computerization of TURA data. Such computerization includes batch processing software to better track production operations, spreadsheets and databases to determine and compare chemical use with reporting thresholds, and incorporation of TURA data elements into facility-wide information management systems.

Despite these improvements, there are numerous opportunities to improve TURA data tracking. For example, eight of the eleven facilities at least partially, and in some cases totally, determine reportable chemicals manually. Only three firms use computers to analyze which chemicals were used over threshold limits. This is a time consuming task without the aid of computers. Facilities with complex batch operations generally lacked good production unit level information on chemical use, byproducts, shipped-in-product, and unit of product. The lack of such information means firms 'gestimated' allocation factors to arrive at materials balance data. The facilities also rarely looked back at the data reported in prior years since the data is not readily available in an easy to comprehend fashion. While this information is important for TUR planning purposes, it is equally important for well-functioning manufacturing operations. The increasing use of 'best practice' TUR reporting would not only provide improved TURA data, but would also provide value to most Massachusetts manufacturers.

The methodology was developed to measure aggregated, state- or industry-wide progress, not progress for a particular facility. It was found to be extremely sensitive to data errors and anomalies in small subsets of the data. For both of these reasons, the reality check project was not able to verify the accuracy of the methodology at the facility level, although it was useful in determining the areas that need to be addressed.

9.1.4 Measurement of Progress - 1990 to 1993

Are Massachusetts industries making progress in toxics use reduction? By nearly all metrics, the answer is yes and leads to the question of how much. Examining all of the metrics and universes together produces a picture of progress. This section summarizes the more relevant quantitative metrics calculated in this study. For each type of quantity (byproduct, use, etc.), the following analyses were performed:

- Actual and Normalized trends for each subset of reportable chemicals and industries (1990 Reportables, 1991 Reportables, and 1992 Reportables)
- Actual and Normalized trends for all reported chemicals and industries in two consecutive years (year to year analysis)
- Actual and Normalized trends for consistently reporting facilities, and for consistently reported chemicals by those facilities
- Actual and Normalized trends for 'top 20' and 'non-top 20' toxic chemical users

The following summarizes the results of those analyses on the various quantities:

Byproduct Generation For the largest consistent universe, Universe 0 or 1990 Reportables, results indicate a 13% actual reduction in quantity of byproduct generated, and a 14% normalized reduction from 1990 to 1993. The byproduct generation for 1991 Reportables decreased, while byproduct increased for 1992 Reportables (over a one year period 1992 - 1993). However, 1990 Reportables comprise the majority of byproduct generated. Therefore, the additional reportable chemicals and industries are unlikely to have a significant impact on the overall percent changes. The year to year trend analysis for all reportable chemicals and industries suggested that there was no change in byproduct generation from 1990 to 1991, followed by a steady decrease in byproduct generation over the next two years (7 and 4% actual reduction and 6 and 10% normalized reduction, respectively).

Total Use For 1990 Reportables, results indicate a 17% actual reduction in total toxic chemical use, and a 19% normalized reduction. The total use for 1991 Reportables increased, while total use decreased for 1992 Reportables. As with byproduct generation, the 1990 Reportables comprise the majority of total use, so the additional reportable chemicals and industries are unlikely to have a significant impact on the overall percent changes. The year to year analysis suggests a consistent trend of reductions in total toxic chemical use over the three years of 4-7% (actual) and 5-10% (normalized).

Shipped in or as Product For 1990 Reportables, results indicate a -5% actual increase in total toxic chemicals shipped in or as product and a -3% normalized increase. The results indicate that additional reportable chemicals and industries will have a negative impact by further increasing the change in shipped in product quantities. 1991 Reportables, at approximately one quarter the magnitude of 1990 Reportables, exhibited a -70% actual increase and a -62% normalized increase from 1991 to 1993. 1992 Reportables exhibited a smaller increase of -10% (actual) and -5% (normalized). While the quantity shipped in or as product could be expected to increase due to increases in production levels, the normalized analysis suggests that the increase was not entirely offset by increases in production.

TRI Releases and Transfers As an aggregate, TRI releases and transfers for 1990 Reportables experienced a reduction of 4% (actual) and 8% (normalized) over the period 1991 to 1993. 1990 data was not used as a baseline due to 1991 changes in reporting guidelines for off-site transfers. While 1990 Reportables still comprise the majority of releases and transfers, both 1991 and 1992 Reportables had significant reductions (18 - 27%). Therefore, the additional reportable chemicals and industries are likely to have a positive impact on progress in reducing toxic chemical releases and transfers over the period 1991 to 1993. It is important to note, however, that when 'releases and transfers' are broken down into their component parts, results indicate substantial reductions for releases to the environment and transfers to POTW's, while transfers off-site increase. Year to year trends for the aggregated TRI releases and transfers quantities indicate an increase from 1991 to 1992 of -4% (actual) and -5% (normalized) offset by a decrease from 1992 to 1993 of 9% (actual) and 15% (normalized).

Top 20 Use Facilities Results showed a marked difference in trends between the 'top 20 use' facilities and the 'non-top 20 use' facilities. The 'top 20 use' facilities represented less than 4% of facilities reporting, but accounted for 70% of the use, 40% of the byproduct, and 50% of the shipped in product total quantities. The 'top 20 use' facilities experienced an actual reduction in total toxic chemicals used of 23% (148 million lb) and a normalized reduction of 20%, from 1990 to 1993. Similarly, 'top 20 use' facilities experienced an actual reduction in byproduct generated of 9% (3 million lb) and a normalized reduction of 5%.

Conversely, the 'non-top 20 use' facilities experienced only a 2% reduction in actual total toxic chemical use (4 million lb), but reported production ratios which suggest increased production levels. Therefore, the 'non-top 20 use' normalized reduction in total use was calculated at 17% for 1990 to 1993. Similarly, the actual reduction in byproduct generated by the 'non-top 20 user' facilities was 15%, while the normalized reduction was 28%.

Consistently Reporting Facilities and Chemicals Facilities using and reporting the same chemicals consistently over 4 years experienced a reduction in toxic chemical byproduct generation of approximately 8%, compared with a 13% reduction for all facilities. This analysis examines the issue of whether facilities and chemicals which drop below or rise above the reporting threshold impact the measurement of progress. When chemicals drop below or rise above the threshold, this causes a quantum drop or increase of 10,000 or 25,000 pounds, when it is likely that the actual quantities are somewhere in between. Results indicated that more chemicals dropped below than came above the threshold, which caused progress to be overstated by as much as 5%, depending on what the actual quantities are in the years in which those chemicals are not reported.

Analysis by Chemical and Industry Groups Analyses by chemical and industry group are useful for determining the source of observed changes in toxic chemical quantities. For this project, these types of small-subset analyses were of great value in identifying data anomalies and errors. Some groups did exhibit clear trends, for example Montreal Protocol chemicals exhibited a greater than 60 % reduction for byproduct generation and total use in both actual and normalized terms. Similarly, releases to the environment for this group was reduced by over 80%. As data quality improves, this type of analysis will be valuable for determining the cause of observed overall changes.

Trade Secret Claims Because there are no trade secret data included in the TURA data extract files which are distributed by DEP, all the analyses shown here exclude all trade secret chemical quantities, as well as quantities for those non-trade secret chemicals which were claimed trade secret by the facility in another year. In 1990, 80% of the chemicals manufactured in

Massachusetts were claimed trade secret. This results in a remaining subset of manufactured chemicals that is too small for progress to be meaningfully measured. Conversely, only 22% of the processed chemicals and 3% of the otherwise used chemicals were claimed trade secret.

Analysis by How a Chemical is Used Chemical use is reported under TURA in three different categories: manufactured, processed, and otherwise used. In 1990, 79% of the total chemical use was reported as processed, 10% was reported as manufactured and 11% was reported as otherwise used.

An experimental approach was developed for examining progress in terms of how a chemical is used: "mostly processed," or "mostly processed and otherwise used." The preliminary analysis suggested that chemicals that are "mostly processed" appear to have greater progress in reducing byproduct generated than chemicals that are "processed and otherwise used," and chemicals that are "processed and otherwise used" appear to have decreased total use and releases to the environment more than chemicals that are " mostly processed." It was also observed that styrene monomer accounts for the majority of processed chemical use, and so has an overpowering effect on any group that it is in. Therefore, "processed" chemicals are analyzed both including and excluding styrene.

In summary, results indicate that there is TUR progress in Massachusetts, although the amount of progress varies depending on which facilities, chemicals, and quantities are examined. The only areas where progress is not observed, are for toxic chemicals shipped in or as product, and for toxic chemicals transferred off-site.

9.2 Recommendations

There are a number of changes that could be made by the TURA agencies that would improve the useability of the TURA data, improve the quality of the data and, in general, make the data and the system more accessible and meaningful for the agencies, the reporting facilities and the public.

9.2.1 Facility Practices

Although TURA data is important for measuring TUR progress in Massachusetts, it is equally important for well-functioning manufacturing operations. Increasing the use of 'Best Practice' TUR reporting would not only improve TURA data, but would also provide value to most Massachusetts manufacturers. There are numerous methods to disseminate 'Best Practice' techniques. These include:

- teaching 'Best Practice' techniques in future TUR Planners courses and in TUR Planner continuing education credit workshops.

- dissemination of 'Best Practice' techniques by OTA, DEP, and TURI through written materials, case studies, inspections, and site-visits.
- Facilities identified either through site-visits or Data Exception reports with the most reporting problems could be singled out for technical assistance and education.

9.2.2 TURA Data Reporting

Changes in Form S reporting could be made which would both reduce the reporting burden on Massachusetts companies and improve the accuracy of reported information. These changes and improvements include the following: (a detailed description of each of these recommendations is included in Appendix K)

- provide for electronic reporting of Form S and Form R,
- provide feedback to facilities on data reported in prior years,
- include a pre-printed label with facility ID, address, and other consistently reported information,
- increase TUR Planner education regarding Form S reporting, and
- eliminate any unnecessary sections (those with data elements which are not used by the state) of state-only Form R.

There are also changes which could be made to Form S reporting which would greatly simplify the useability of the data for measuring progress and other types of analysis. These changes include the following: (a detailed description of each of these recommendations is included in Appendix K)

- for newly reportable chemicals and industries, request estimate of 1987 quantities in order to maintain a 1987 baseline,
- include TRI ID number on Form S and in FMF database,
- include a facility-level SIC code on Form S,
- clarify reporting and data management for wastewater treatment and metal bender exemption chemicals,
- require designation of a wastewater treatment production unit when wastewater treatment is responsible for more than 50% of a chemical's use,
- clarify instructions for TUR codes and include a TUR code category "unknown reasons for change,"
- revise optional section for 'reasons that a chemical is not longer reported' so that it is required and so that it is clear whether TUR was responsible for reductions below thresholds,
- require facilities to provide some data (with no associated fee) for the year in which a facility or chemical drops below the threshold, and
- improve metal bender exemption reporting to clarify for which metals an exemption is being requested.

9.2.3 Data Management

Changes to the data entry procedures and DEP's FMF system that would improve the useability of the TURA data include:

- allow deletion of records entered in error,
- prevent entering of non-reportable chemical CAS numbers,
- prevent entering of duplicate key records,
- create consistent method for entering BRI = 0 versus BRI = N/A, and
- create a facility 'history' file in FMF and extract files that includes changes to facility ID, name, address, production unit numbers and production unit descriptions.

9.2.4 Further Analysis and Investigation

There are a number of issues raised during this study which warrant further investigation or require further data analysis. The first task will be to rerun the analysis using a further refined 1990 data set and the 1994 TURA and TRI data, when they are released. This will provide a better 1990 baseline, particularly for byproduct, against which to measure progress, and will provide five years of data, further reducing the effect of data anomalies and short-term trends.

The second addition to the data will be the establishment of a 1987 baseline, from which to estimate progress over the 1987 to 1990 (or first year reported) period. This information, together with the 1990 to 1994 data analysis, will provide an estimate of progress toward the 50% byproduct reduction goal during the first 7 years (1987 to 1994) of the 10 year period.

9.2.4.1 Normalization Metrics

There are several issues regarding the normalization methodology which require further investigation. The first is a more thorough testing of the TRI Production Ratio/Activity Index as a proxy for level of production. It is unclear how confident facilities are of this value, how well the aggregated ratio reflects conditions in general, and what the sensitivity to production ratio error is in the normalization methodology.

The production ratio was used for this study because the preferred measure, a facility's unit of product quantity, is not collected on the Form S. There are a number of ways to address this data gap. Firms already use their unit of product to calculate a normalized measure of byproduct and emission reduction progress at the production unit level (BRI and ERI). One option is to add a facility-wide BRI, by having companies calculate a weighted average based on each production unit's use relative to the total. In addition to a BRI, a measure of use reduction (Use Reduction Index - URI, or Input Reduction Index - IRI) and an ERI (XRI[1]) could be reported. This would preserve the separation between a facility's production unit information and their chemical quantities. These overall measures of progress for each facility could then be aggregated based on the facility's use relative to the total, to produce a state-wide measure. Other alternatives for filling the data gap are to have facilities provide the unit of product quantities, or to report chemical quantities at the production unit level.

There are additional benefits to collecting a facility-wide aggregated metric. One of the drawbacks of having reporting thresholds is that chemicals and facilities fall below the threshold and all final data is lost for those chemicals. A facility-wide metric could incorporate all chemicals that had ever been reported, not just those for which the facility was currently required to report. For example, BRI's or URI's equal to 100, which would occur when the chemical was no longer used but the product was still being produced, could be incorporated into the total. Currently, that "last year" is lost when calculating quantitative measures of progress.

There are still many issues which need to be addressed regarding a facility-wide XRI. A critical issue is the existing quality of the BRI data being reported. Both the Reality Check and the data consistency check found many of the BRI data to be of poor or uncertain quality. This would need to be addressed by improving education, TURA Form S guidance documents, and implementation of facility 'Best Practices.' Other important issues to be addressed include: establishing a common base year and reporting a total quantity which could be used for weighting in a state-wide weighted average XRI.

Reporting of a comprehensive facility-wide XRI could potentially provide an accurate normalized metric for state-wide progress *by LQTU facilities* in the Commonwealth. It is a good metric for assessing progress in reducing use and byproduct generation for the chemicals which are already being used by LQTU facilities. There are, however, TUR activities which are not included in this type of metric. They are those for which reporting was never required; principally, this includes small quantity users and those who incorporate TUR into the initial design of a product or process. A state-wide indicator of production, if one were available, would capture this expanded cleaner manufacturing base, where production ratios for individual reporting facilities and processes will not.

9.3 Summary

This study has demonstrated the potential for using TURA and TRI data to measure toxics use reduction progress in Massachusetts. The use, byproduct and shipped in product quantity data and production unit data which are reported under TURA provide valuable information about trends in chemical use patterns. For the period 1990 to 1993, the methodology clearly indicates a

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[1]The general term 'XRI' will be used to describe these potential facility-wide measures.

reduction in toxic chemicals used and byproducts generated. While there are currently some limitations to useability of the data, it is still a relatively new reporting requirement, and is undergoing continuous improvement. Even with these limitations, the data is a valuable resource for measuring progress in toxics use reduction.

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APPENDIX

A. TURA Form S
- A1 - TURA Form S Data Diagram
- A2 - Form S
- A3 - Reporting Package Instructions

B. TURA Chemicals
- B1 - All Chemicals Reported by Year Reporting First Required
- B2 - Methodology Chemical Groups
- B3 - Full TURA Chemical List

C. SIC Code User Segment Groups

D. TRI Form R
- D1 - TRI Form R Data Diagram
- D2 - Form R
- D3 - Production Ratio/Activity Index

E. Previous Measuring Progress Studies
- E1 - Tufts University Capstone Report
- E2 - Tellus Institute Study

F. Examples of TURA Data Structure Issues

G. 1987 Baseline
- G1 - 1987 Baseline Information Survey
- G2 - Pilot Results

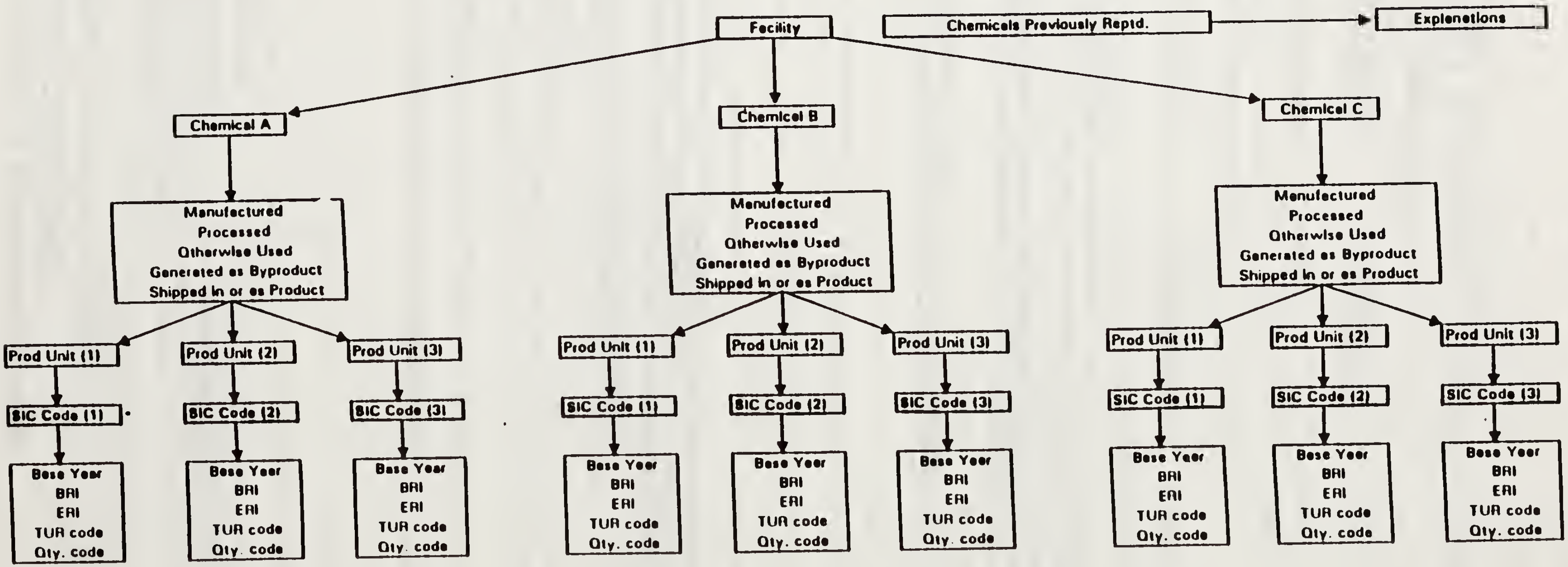
H. TURA Data Issues

I. TURA Data Analysis Universes

J. TURA Data Analysis Results
- J1 - Paradox™ Summary Reports
- J2 - Universe Percentages
- J3 - Chemical Category Analysis
- J4 - Industry Segment Analysis

K. Recommendations for Modifications to Form S Reporting

Figure A1-1. TURA Form S Data



* An SIC code is reported for each production unit (i.e. if two chemicals are reported for a single production unit, they will both be classified by the same SIC code).

Source: Tellus Institute, "Taking Stock: Measuring Toxics Use Reduction Progress in Massachusetts", March 1995

Massachusetts Department of Environmental Protection

TURA REPORT - COVER SHEET

Toxic Use Reduction Act - Form S Cover Sheet

Section 1: General Information

1.1 ATTACH MAILING LABEL with facility name address & DEP Facility Identification Number

ATTACH CORRECTED MAILING LABEL or enter facility, name & address

1.2 Are you making a trade secret claim for any of the information submitted in this COVER SHEET and/or Form S(s)? ____YES ____No

1.3 If YES, attach a statement substantiating the claim. Is this copy: ____Sanitized ____Unsanitized

1.4 This report is being filed for reporting year: 19__________

Section 2: Certification Statement

2.0 This CERTIFICATION STATEMENT should be signed after all the forms have been completed.

I hereby certify that I have reviewed this and all attached documents and that, to the best of my knowledge and belief, the submitted information is true and complete and that the amounts and values in these documents are accurate bas. on measurements and/or reasonable estimates using data available to the preparers of these documents. I am aware that there are significant penalties for willful or intentional submission of false or incomplete information.

______________________________ ______________________________

Authorized Signature Print Name

______________________________ ______________________________

Position/Title Date

Section 3: Chemicals Previously Reported That Are Not Reportable This Year

3.0 OPTIONAL QUESTION. In this section, you may provide information on any chemical reported last year that is not subject to reporting this year. If you substituted a non-listed chemical for a TURA chemical, you may identify the substitution, as well.

The codes to explain why the chemical is not reportable are: [1] Chemical Below Threshold But > 0 [2] No Chemical Usage in Reporting Year [3] Chemical Substitution [4] Chemical Eliminated (No Substitution) [5] Decline in Business [6] Other (Explain below in the additional comments section). Enter all the codes that apply.

3.1 ______________________________ ______________________________

CAS # of Chemical Not Reportable (if applicable) Chemical Name

Explanation of Why the Chemical Is Not Reportable. (Enter Code): |___| |___| |___| |___|

______________________________ ______________________________

CAS # of Chemical Substituted for TURA Chemical Chemical Name

3.2 ______________________________ ______________________________

CAS # of Chemical Not Reportable (if applicable) Chemical Name

Explanation of Why the Chemical Is Not Reportable. (Enter Code): |___| |___| |___| |___|

______________________________ ______________________________

CAS # of Chemical Substituted for TURA Chemical Chemical Name

Additional Comments: ____

____

FORM S COVER SHEET (continued)

Section 4: *Facility-Wide Listing of Production Units*

A PRODUCTION UNIT is best thought of as the combination of the process (or activities) used to produce a product or service and the product or service. In this block, please identify the PRODUCTION UNITS at the facility, then use the production unit number to report on chemical usage in the attached Form S. If there is a substantial change in a PRODUCTION UNIT from one reporting year to the next, the PRODUCTION UNIT must be given a new, unique number.

Production Unit #001

This Production Unit (Process/Product Combination) is: ____ The Same As Reported Last Year ____ New

Describe the Process: ______________________________

____

____

Describe the Product: ______________________________

____

Product SIC Code: |___|___|___|___| |___|___|___|___| |___|___|___|___| |___|___|___|___|

Describe the Unit of Product: ______________________________
(Please specify if the Unit of Product has been changed since the previous reporting year.)

Production Unit #002

This Production Unit (Process/Product Combination) is: ____ The Same As Reported Last Year ____ New

Describe the Process: ______________________________

____

____

Describe the Product: ______________________________

____

Product SIC Code: |___|___|___|___| |___|___|___|___| |___|___|___|___| |___|___|___|___|

Describe the Unit of Product: ______________________________
(Please specify if the Unit of Product has been changed since the previous reporting year.)

Production Unit #003

This Production Unit (Process/Product Combination) is: ____ The Same As Reported Last Year ____ New

Describe the Process: ______________________________

____

____

Describe the Product: ______________________________

____

Product SIC Code: |___|___|___|___| |___|___|___|___| |___|___|___|___| |___|___|___|___|

Describe the Unit of Product: ______________________________
(Please specify if the Unit of Product has been changed since the previous reporting year.)

FORM S COVER SHEET (continued)

Section 4: Facility-Wide Listing of Production Units

A PRODUCTION UNIT is best thought of as the combination of the process (or activities) used to produce a product or service and the product or service. In this block, please identify the PRODUCTION UNITS at the facility, then use the production unit number to report on chemical usage in the attached Form S. If there is a substantial change in a PRODUCTION UNIT from one reporting year to the next, the PRODUCTION UNIT must be given a new, unique number.

Production Unit #: ____________

This Production Unit (Process/Product Combination) is: ____ The Same As Reported Last Year ____ New

Describe the Process: ______________________________

Describe the Product: ______________________________

Product SIC Code: |___|___|___|___| |___|___|___|___| |___|___|___|___| |___|___|___|___|

Describe the Unit of Product: ______________________________
(Please specify if the Unit of Product has been changed since the previous reporting year.)

Production Unit #: ____________

This Production Unit (Process/Product Combination) is: ____ The Same As Reported Last Year ____ New

Describe the Process: ______________________________

Describe the Product: ______________________________

Product SIC Code: |___|___|___|___| |___|___|___|___| |___|___|___|___| |___|___|___|___|

Describe the Unit of Product: ______________________________
(Please specify if the Unit of Product has been changed since the previous reporting year.)

Production Unit #: ____________

This Production Unit (Process/Product Combination) is: ____ The Same As Reported Last Year ____ New

Describe the Process: ______________________________

Describe the Product: ______________________________

Product SIC Code: |___|___|___|___| |___|___|___|___| |___|___|___|___| |___|___|___|___|

Describe the Unit of Product: ______________________________
(Please specify if the Unit of Product has been changed since the previous reporting year.)

DEP FACILITY ID#: ______________

Page ___ of ___

Massachusetts Department of Environmental Protection

TURA REPORT - FORM S

Toxic Use Reduction Act - Chemical Usage Facility-Wide & by Production Units

Section 1: Facility-Wide Usage of Listed Chemical

1.1 ______________________ ______________________

Chemical Abstract Service (CAS) Number (if applicable) — Chemical Identification (from Form R)

1.2 Facility-Wide Usage of Chemical Identified in 1.1 above. Enter total amount (in POUNDS) for each applicable category.
NOTE: Byproduct (item 1.2d) generally means all wastes containing the listed chemical before the waste is treated or recycled. Read the instructions carefully, however, before completing this section.

1.2a Manufactured: ______________

1.2b Processed: ______________

1.2c Otherwise Used: ______________

1.2d Generated as Byproduct: ______________

1.2e Shipped in or as Product: ______________

1.3 OPTIONAL QUESTION. When the amounts reported in 1.2a, 1.2b, and 1.2c are added together, the sum will – in many cases – equal the sum of 1.2d and 1.2e. In other words, the left and right columns will often form a "materials balance." If the two columns are not in approximate balance, you may use this block to explain why. Mark all the reasons that apply.

____ Chemical was recycled on site. ____ Chemical was consumed or transformed.

____ Chemical was held in inventory. ____ Chemical is a compound.

____ Other (explain): ______________________________

1.4 OPTIONAL QUESTION: Did anything non-routine occur at your facility during the reporting year which affected the data reported?

____ YES ____ NO If YES, you may use this space to comment: ______________________________

____

Section 2: Chemicals Used in Waste Treatment Units

2.1 Is this chemical used to treat waste or control pollution? ____ YES ____ NO

If YES, enter the quantity of chemical code for the amount used to treat waste or control pollution: ¦___¦

OPTIONAL – You may enter the amount: ______________

Section 3: TURA Report on Production Unit #: __________ (Enter # from the Form S Cover Sheet.)

3.1 Base Year: ________

3.2 Quantity of Chemical Code: ¦___¦

3.3 Toxics Use Reduction Techniques Code: ¦___¦___¦ ¦___¦___¦ ¦___¦___¦ ¦___¦___¦ ¦___¦___¦ ¦___¦___¦ ¦___¦___¦

3.4 Byproduct Reduction Index: _____

3.5 Emissions Reduction Index: _____

If there has been a change from one reporting year to the current year in a (1) base year, and/or (2) estimating methods (that significantly alter previously reported data) for this PRODUCTION UNIT REPORT, describe the change:

____

TURA Report on Production Unit #: ________ (Enter # from the Form S Cover Sheet.)

3.1 Base Year: ________ 3.4 Byproduct Reduction Index: _____

3.2 Quantity of Chemical Code: |__| 3.5 Emissions Reduction Index: _____

3.3 Toxics Use Reduction Techniques Code: |__|__| |__|__| |__|__| |__|__| |__|__| |__|__| |__|__|

If there has been a change from one reporting year to the current year in a (1) base year, and/or (2) estimating methods (that significantly alter previously reported data) for this PRODUCTION UNIT REPORT, describe the change:

____

TURA Report on Production Unit #: ________ (Enter # from the Form S Cover Sheet.)

3.1 Base Year: ________ 3.4 Byproduct Reduction Index: _____

3.2 Quantity of Chemical Code: |__| 3.5 Emissions Reduction Index: _____

3.3 Toxics Use Reduction Techniques Code: |__|__| |__|__| |__|__| |__|__| |__|__| |__|__| |__|__|

If there has been a change from one reporting year to the current year in a (1) base year, and/or (2) estimating methods (that significantly alter previously reported data) for this PRODUCTION UNIT REPORT, describe the change:

____

TURA Report on Production Unit #: ________ (Enter # from the Form S Cover Sheet.)

3.1 Base Year: ________ 3.4 Byproduct Reduction Index: _____

3.2 Quantity of Chemical Code: |__| 3.5 Emissions Reduction Index: _____

3.3 Toxics Use Reduction Techniques Code: |__|__| |__|__| |__|__| |__|__| |__|__| |__|__| |__|__|

If there has been a change from one reporting year to the current year in a (1) base year, and/or (2) estimating methods (that significantly alter previously reported data) for this PRODUCTION UNIT REPORT, describe the change:

____

TURA Report on Production Unit #: ________ (Enter # from the Form S Cover Sheet.)

3.1 Base Year: ________ 3.4 Byproduct Reduction Index: _____

3.2 Quantity of Chemical Code: |__| 3.5 Emissions Reduction Index: _____

3.3 Toxics Use Reduction Techniques Code: |__|__| |__|__| |__|__| |__|__| |__|__| |__|__| |__|__|

If there has been a change from one reporting year to the current year in a (1) base year, and/or (2) estimating methods (that significantly alter previously reported data) for this PRODUCTION UNIT REPORT, describe the change:

____

Toxics Use Reduction Techniques Matrix

In this matrix, toxic use reduction techniques mark the rows and production operations head the columns. Within the matrix, a two-digit code appears the intersection of each row and column.

If a technique as applied to a production operation accounted for an increase of five or more points in the byproduct reduction index between the base year and reporting year, enter the code for that matrix cell in BLOCK 3.4 of FORM S. Enter all the codes that apply.

You may enter a "miscellaneous" code if two or more techniques (not otherwise entered) together accounted for an increase of five or more points.

	Materials Handling/Storage	Processing Operations	Finished Goods Handling
INPUT SUBSTITUTION: Changing the raw materials of product to use non- or less toxic materials.	10	11	12
PRODUCT REFORMULATION: Reformulating or redesigning end-products to be non- or less toxic upon use, release, or disposal.	20	21	22
PRODUCTION UNIT REDESIGN OR MODIFICATION: Using production units of a different design than those used previously.	30	31	32
PRODUCTION UNIT MODERNIZATION: Upgrading or replacing production unit equipment or methods.	40	41	42
IMPROVED OPERATION & MAINTENANCE OF PRODUCTION UNIT EQUIPMENT & METHODS: Modifying existing equipment/methods by such steps as improved housekeeping, system adjustments or process/product inspections.	50	51	52
RECYCLING, REUSE, OR EXTENDED USE OF TOXICS: Using equipment/methods that are integral to the production unit.	60	61	62
MANAGEMENT TECHNIQUE OF USING BYPRODUCT AS PRODUCT: Use of byproduct without further treatment when the byproduct would have otherwise been released, treated, or shipped off-site for recycling/reuse	70	71	72
MISCELLANEOUS	80	81	82

BYPRODUCT REDUCTION INDEX[2]

The byproduct reduction index is calculated as follows:

$$BRI = 100 \times \frac{A - B}{A}$$

A = $\frac{\text{Byproduct quantity in the base year}}{\text{\# of units of product produced in the base year}}$

B = $\frac{\text{Byproduct quantity in the reporting year}}{\text{\# of units of product produced in the reporting year}}$

For instance, a paper manufacturer has sulfuric acid as a byproduct and uses square feet of paper as the "unit of product." In 1990, the company's base year, the company made 1 million square feet of paper type A and generated 50,000 lbs. of sulfuric acid as byproduct. In 1994, the company instituted toxics use reduction techniques that reduced the amount of sulfuric acid that became byproduct. That year, the company made 1.5 million square feet of paper type A and generated 25,000 lbs. of sulfuric acid as byproduct.

$$BRI = 100 \times \frac{\frac{50{,}000 \text{ lbs.}}{1{,}000{,}000 \text{ sq ft}} - \frac{25{,}000 \text{ lbs.}}{1{,}500{,}000 \text{ sq ft}}}{\frac{50{,}000 \text{ lbs.}}{1{,}000{,}000 \text{ sq ft}}}$$

$$BRI = 100 \times \frac{.05 - .0166}{.05}$$

$$BRI = 100 \times .668$$

$$BRI = 66.8 \text{ rounded up to } = 67$$

Item 3.5: Emissions Reduction Index.

The emissions reduction index is calculated as follows:

$$ERI = 100 \times \frac{A - B}{A}$$

A = $\frac{\text{Emissions quantity in the base year}}{\text{\# of units of product produced in the base year}}$

---

[2] If you change your definition of your production unit or your unit of product, you may need to recalculate your BRI and ERI. Please see Appendix C for further information on how to do this.

$$B = \frac{\text{Emissions quantity in the reporting year}}{\text{\# of units of product produced in the reporting year}}$$

The emissions reduction index is calculated in the same way as the BRI. However, emissions estimates should be collected while completing the Form R. If two or more production units contribute a chemical to a single waste treatment or recycling process, the emissions must be attributed to each of the different production units.

Discuss how to attribute emissions across all the production units with a process engineer and/or pollution control engineer.

BYPRODUCTS VS EMISSIONS

A byproduct is any non-product output of a listed chemical prior to handling, transfer, treatment, or release to the environment. An emission is any byproduct that leaves your facility boundary directly or after treatment or recycling.

A BYPRODUCT IS ANY AMOUNT OF A TURA CHEMICAL THAT LEAVES THE PRODUCTION UNIT AS PART OF:

Fugitive Emissions (or evaporative losses)
Wastewaters
Spent Materials Going to Onsite or Offsite Recycling
Solid Waste
Stack Emissions
Hazardous Waste

EMISSIONS UNDER TURA

Emissions include the amount of a listed chemical that:

- Goes to the sewer or public wastewater treatment facility
- Leaves the facility as fugitive or stack emissions
- Leaves the facility as solid or hazardous waste
- Leaves the facility to be treated, disposed of, or recycled off-site

Item 3.3: <u>Toxics Use Reduction Technique Code</u>. Enter the appropriate toxic use reduction technique code for any production unit that has a base year prior to 1994.

The Toxics Use Reduction Techniques Matrix (the last page of the reporting forms) lists the associated codes for the techniques.

Determine which reduction or management technique listed in the vertical axis accounts for any increase in the byproduct reduction index. Then determine where in the production operations the reduction or management technique took place -- in materials handling/storage, processing operations or finished goods handling.

If the byproduct reduction index increased by five or more points over the index for the previous year, write in the appropriate code in the matrix. If two or more reduction techniques together accounted for a five or more point increase, you may enter the appropriate "miscellaneous" code. It will be more useful, however, if you list all the applicable codes.

The following example illustrates how to fill out the matrix.

TUR TECHNIQUES MATRIX

A boat manufacturer implements various toxics use reduction techniques in calendar year 1994 The byproduct reduction index for 1994 is 18, an increase of 12 over the previous year (1993), in which the index was 6.

Six points of the increase are due to a change in raw materials in which a non-toxic substance was substituted for a toxic substance. Under the process operations column, 11 is chosen for input substitution.

The other six points resulted from a combination of toxics use reduction techniques: toxics reuse and improved maintenance. Since neither of these changes accounted for 5 points individually, the firm could mark 81 in the process operation column for miscellaneous.

As an alternative, it could mark 61 (toxics reuse) an 51 (improved operations and maintenance).

As a final step in Section 3, report any changes in waste estimation methods or a base year. You may also use this space to explain any unusual circumstances, such as a spill or accident that influenced your BRI or ERI.

WHAT IS TOXICS USE REDUCTION?

Toxics Use Reduction is defined in the Toxic Use Reduction Act of 1989 as:

> In-plant changes in production processes or raw materials that reduce, avoid, or eliminate the use of toxic or hazardous substances or generation of hazardous byproducts per unit of product, so as to reduce risks to the health of worker, consumers, or the environment without shifting risks between workers, consumers or parts of the environment. Toxic use reduction shall be achieved through any of the following techniques:

Input substitution is replacing a toxic or hazardous substance or raw material used in a production unit with a non-toxic or less toxic substance.

- Aqueous cleaning instead of solvent cleaning
- Soy based inks instead of chemical inks
- Alkaline plating baths instead of cyanide baths

Product reformulation is substituting for an existing end-product, an end-product which is non-toxic or less toxic upon use, release or disposal.

- Latex based coatings instead of oil based coatings
- Unbleached paper instead of bleached paper

Production Unit Redesign or Modification is developing and using production units of a different design than those currently used.

- Ozonation instead of chlorine based system for controlling corrosion
- Electrostatic powder paint spray instead of solvent based paint

Production Unit Modernization is upgrading or replacing existing production unit equipment and methods with other equipment and methods based on the same production unit.

- Continuous closed system instead of batch process
- Countercurrent and reactive rinsing instead of single tank rinsing in electroplating

Improved Operation and Maintenance of Production Unit Equipment is modifying or adding to existing equipment or methods including, but not limited to, such techniques as improved housekeeping practices, system adjustments, product and process inspections, or production unit control equipment or methods.

- Installation of Floating Roofs on Chemical Storage Tanks (instead of no roofs)
- Strict inventory controls to prevent expiration of chemicals

Recycling, Reuse, or Extended Use of Toxics is by using equipment or methods which become an integral part of the production unit of concern, including but not limited to filtration and other closed loop methods.

- Acid regeneration instead of disposal of acid
- Silver recycling unit instead of discharge of silver in wastewater

WHAT ISN'T TOXICS USE REDUCTION?

Toxics use reduction focuses on the production process, rather than the byproduct. In other words, "reduction" is to occur through changes in the production process, rather than through changes in how the waste generated by the production process is handled. Thus, toxic use reduction does not include any practice which promotes or requires, or which is:

- Shifting the toxic discharge from one medium to another (air to water)
- Recycling, unless it is integral to the production process
- Treatment of toxic waste to make it less toxic or non-toxic and
- Incineration

This section contains a list of all the chemicals that have ever been reported by TURA facilities. Note that the list does not include chemicals that are required to be reported but have never been reported by a TURA facility. The list is ordered by the year the chemical was first required to be reported under TURA. The first group of chemicals, with Year-Added Date of 00, are chemicals that were reported by facilities but were never required to be reported. These were reported in error but have been entered into the TURA database. The list includes the Chemical Abstract Service (CAS) Number and the chemical name as it appears in the extract files.

Year-Added : 00 Number of Chemicals Added : 6

64175	DENATURED ALCOHOL
110430	METHYL (N-AMYL) KETONE
110543	HEXANE (N-HEXANE)
111762	2-BUTOXYETHANOL
614788	THIOUREA, (2-METHYLPHENYL)-
1558254	TRICHLORO(CHLOROMETHYL)SILANE

Year-Added : 90 Number of Chemicals Added : 133

1000	ANTIMONY COMPOUNDS
1001	ARSENIC COMPOUNDS
1002	BARIUM COMPOUNDS
1004	CADMIUM COMPOUNDS
1012	CHROMIUM AND COMPOUNDS
1013	COBALT COMPOUNDS
1015	COPPER COMPOUNDS
1016	CYANIDE COMPOUNDS
1022	GLYCOL ETHERS
1026	LEAD COMPOUNDS
1027	MANGANESE COMPOUNDS
1029	NICKEL AND COMPOUNDS
1036	SELENIUM AND COMPOUNDS
1037	SILVER AND COMPOUNDS
1039	ZINC AND COMPOUNDS
50000	FORMALDEHYDE
56235	CARBONTETRACHLORIDE
62533	ANILINE
62566	THIOUREA
64675	DIETHYLSULFATE
67561	METHANOL
67630	ISOPROPYLALCOHOL
67641	ACETONE
67663	CHLOROFORM
71363	BUTYLALCOHOLA
71556	TRICHLOROETHANEA
74839	BROMOMETHANE
74851	ETHYLENE
74873	CHLOROMETHANE
75058	ACETONITRILE
75070	ACETALDEHYDE
75092	DICHLOROMETHANE
75218	ETHYLENEOXIDE
75274	DICHLOROBROMOMETHANE
75445	PHOSGENE
75558	PROPYLENEIMINE
75569	PROPYLENEOXIDE
75650	BUTYLALCOHOLC
76131	FREON113
78922	BUTYLALCOHOLB
78933	METHYLETHYLKETONE
79016	TRICHLOROETHYLENE
79061	ACRYLAMIDE
79107	ACRYLICACID
80057	ISOPROPYLIDENED
80626	METHYLMETHACRYLATE

Year-Added : 90 Number of Chemicals Added : 133

81889	CIFOODRED15
84662	DIETHYLPHTHALATE
84742	BUTYLPHTHALATE
85449	PHTHALICANHYDRIDE
85687	BUTYLBENZYLPHTHALA
88755	NITROPHENOLA
90948	MICHLERSKETONE
91087	TOLUENEDIISOCYANATEA
91203	NAPHTHALENE
92524	BIPHENYL
94360	BENZOYLPEROXIDE
95487	CRESOLB
95501	DICHLOROBENZENEA
95636	TRIMETHYLBENZ
96128	DBCP
96333	METHYLACRYLATE
96457	ETHYLENETHIOUREA
97563	CISOLVENTYELLOWA
98828	CUMENE
98953	NITROBENZENE
100414	ETHYLBENZENE
100425	STYRENEMONOMER
101144	METHYLENEBISCHLORO
101688	METHYLENEBISPHENYL
103231	BISETHYLHEXYL
106423	XYLENEC
106467	DICHLOROBENZENEC
106503	PHENYLENEDIAMINE
106898	EPICHLOROHYDRIN
107051	ALLYLCHLORIDE
107062	DICHLOROETHANE
107131	ACRYLONITRILE
107211	ETHYLENEGLYCOL
108054	VINYLACETATE
108101	METHYLISOBUTYLKETO
108316	MALEICANHYDRIDE
108394	CRESOLA
108883	TOLUENE
108907	CHLOROBENZENE
108952	PHENOL
109864	METHOXYETHANOL
110805	ETHOXYETHANOL
110827	CYCLOHEXANE
110861	PYRIDINE
111422	DIETHANOLAMINE
117817	DIETHYLHEXYLPHT
117840	DIOCTYLPHTHALATE
123319	HYDROQUINONE
123728	BUTYRALDEHYDE
123911	DIOXANE
127184	TETRACHLOROETHYLENE
131113	DIMETHYLPHTALATE
140885	ETHYLACRYLATE
141322	BUTYLACRYLATE
302012	HYDRAZINE
584849	TOLUENEDIISOCYANATEB
1163195	DECABROMODIPHENYLOX
1319773	CRESOLMIXEDISOMER
1330207	XYLENEMIXEDISOMER
1336363	POLYCHLORINATEDBIPH
1344281	ALUMINUMOXIDE
2832408	CIDISPERSEYELLOW
6484522	AMMONIUMNITRATE
7429905	ALUMINUM
7439921	LEAD
7439965	MANGANESE
7440020	NICKEL
7440224	SILVER
7440360	ANTIMONY
7440382	ARSENIC
7440393	BARIUM
7440439	CADMIUM
7440473	CHROMIUM
7440484	COBALT
7440508	COPPER
7647010	HYDROCHLORICACID
7664382	PHOSPHORICACID
7664393	HYDROGENFLUORIDE
7664417	AMMONIA
7664939	SULFURICACID
7697372	NITRICACID
7782492	SELENIUM
7782505	CHLORINE
7783202	AMMONIUMSULFATE
8001589	CREOSOTE
25321226	DICHLOROBENZENEMIX
26471625	TOLUENEDIISOCYANATEC

Year-Added : 91 Number of Chemicals Added : 36

60004	ETHYLENEDIAMINE-TETRAACETIC ACID (EDTA)
60297	ETHYLETHER
64186	FORMIC ACID
64197	ACETIC ACID
75047	MONOETHYLAMINE
75207	CALCIUM CARBIDE
75503	TRIMETHYLAMINE
75638	TRIFLUOROBROMOMETHANE
75694	TRICHLOROMONOFLUOROMETHANE
75718	DICHLORODIFLUOROMETHANE
78591	ISOPHORONE
78831	ISOBUTYL ALCOHOL
79221	METHYLCHLOROFORMATE
95578	CHLOROPHENOL
98011	FURFURAL
98862	ACETOPHENONE
99558	NITROTOLUIDINE
107153	ETHYLENEDIAMINE
108247	ACETIC ANHYDRIDE
108463	RESORCINOL
108941	CYCLOHEXANONE
108985	THIOPHENOL
109068	PICOLINE
109897	DIETHYLAMINE
109999	FURAN, TETRAHYDRO-
110167	MALEICACID
110178	FUMARIC ACID
110190	BUTYL ACETATE-I
121448	TRIETHYLAMINE
123864	BUTYLACETATE
124049	ADIPIC ACID
124403	DIMETHYLAMINE
126987	METHACRYLONITRILE
141786	ETHYLACETATE
143339	SODIUM CYANIDE (Na(CN))
156605	DICHLOROETHYLENE

Year-Added : 92 Number of Chemicals Added : 13

353593	BROMOCHLORODIFLUOROMETHANE (HALON 1211)
540885	BUTYL ACETATE-T
594423	PERCHLOROMETHYLMERCAPTAN
1066337	AMMONIUMBICARBONATE
1309644	ANTIMONYTRIOXIDE

Year-Added : 92 Number of Chemicals Added : 13

1310583	POTASSIUMHYDROXIDE
1310732	SODIUM HYDROXIDE
1314132	ZINC OXIDE FUME
1336216	AMMONIUMHYDROXIDE
1341497	AMMONIUMBIFLUORIDE
7440235	SODIUM
7440666	ZINC
7558794	SODIUM PHOSPHATE, DIBASIC

Year-Added : 93 Number of Chemicals Added : 36

1033	PHTHALATE ESTERS
7601549	SODIUM PHOSPHATE, TRIBASIC
7631905	SODIUM BISULFITE
7632000	SODIUM NITRITE
7681494	SODIUM FLUORIDE
7681529	SODIUM HYPOCHLORITE
7705080	FERRICCHLORIDE
7720787	FERROUSSULFATE
7738945	CHROMIC ACID
7758294	SODIUM PHOSPHATE, TRIBASIC
7758943	FERROUSCHLORIDE
7758976	LEAD CHROMATE
7758987	CUPRIC SULFATE
7.761888	SILVERNITRATE
7773060	AMMONIUMSULFAMATE
7778543	CALCIUM HYPOCHLORITE
7782630	FERROUSSULFATE
7790945	CHLOROSULFONIC ACID
8014957	SULFURICACID (FUMING)
10022705	SODIUM HYPOCHLORITE
10025873	PHOSPHORUS OXYCHLORIDE
10028225	FERRICSULFATE
10043013	ALUMINUMSULFATE
10045893	FERROUSAMMONIUM SULFATE
10099748	LEADNITRATE
10101538	CHROMIC SULFATE
10101890	SODIUM PHOSPHATE, TRIBASIC
10102439	NITRICOXIDE
10102440	NITROGEN DIOXIDE
10588019	SODIUM BICHROMATE
12125018	AMMONIUMFLUORIDE
12125029	AMMONIUMCHLORIDE
14639986	ZINCAMMONIUM CHLORIDE
25155300	SODIUM DODECYLBENZENESULFONATE
27176870	DODECYLBENZENESULFONIC ACID
30525894	PARAFORMALDEHYDE

This section contains a list of the chemical in the chemical groups that were analyzed. The list includes the name of the group, the Chemical Abstract Number (CAS), the first year that the chemical was required to be reported under TURA, and the name of the chemical as it appears in the TURA extract files.

Chemical Group: Acids

7647010	90	HYDROCHLORIC ACID
7697372	90	NITRIC ACID
7664382	90	PHOSPHORIC ACID
7664939	90	SULFURIC ACID

Chemical Group: Metals

7440360	90	ANTIMONY
1000	90	ANTIMONY COMPOUNDS
7440382	90	ARSENIC
1001	90	ARSENIC COMPOUNDS
7440393	90	BARIUM
1002	90	BARIUM COMPOUNDS
7440439	90	CADMIUM
1004	90	CADMIUM COMPOUNDS
7440473	90	CHROMIUM
1012	90	CHROMIUM & COMPOUNDS
7440484	90	COBALT
1013	90	COBALT COMPOUNDS
7440508	90	COPPER
1015	90	COPPER COMPOUNDS
7439921	90	LEAD
1026	90	LEAD COMPOUNDS
7439965	90	MANGANESE
1027	90	MANGANESE COMPOUNDS
7440020	90	NICKEL
1029	90	NICKEL AND COMPOUNDS
7782492	90	SELENIUM
1036	90	SELENIUM AND COMPOUNDS
7440224	90	SILVER
1037	90	SILVER AND COMPOUNDS
7440666	92	ZINC
1039	90	ZINC AND COMPOUNDS

Chemical Group: Carcinogens

75070	90	ACETALDEHYDE
79061	90	ACRYLAMIDE
107131	90	ACRYLONITRILE
7440382	90	ARSENIC
7440439	90	CADMIUM
56235	90	CARBONTETRACHLORIDE
67663	90	CHLOROFORM
95578	91	CHLOROPHENOL
7440473	90	CHROMIUM
8001589	90	CREOSOTE
106467	90	DICHLOROBENZENEC
25321226	90	DICHLOROBENZENEMIX
107062	90	DICHLOROETHANE
75092	90	DICHLOROMETHANE
117817	90	DIETHYLHEXYLPHT
64675	90	DIETHYLSULFATE
123911	90	DIOXANE
106898	90	EPICHLOROHYDRIN
140885	90	ETHYLACRYLATE
75218	90	ETHYLENEOXIDE
96457	90	ETHYLENETHIOUREA
50000	90	FORMALDEHYDE
302012	90	HYDRAZINE
7439921	90	LEAD
7758976	93	LEADCHROMATE
101144	90	METHYLENEBISCHLORO
90948	90	MICHLERSKETONE
7440020	90	NICKEL
1029	90	NICKEL AND COMPOUNDS
1336363	90	POLYCHLORINATEDBIPH
75558	90	PROPYLENEIMINE
75569	90	PROPYLENEOXIDE
100425	90	STYRENEMONOMER
127184	90	TETRACHLOROETHYLENE
62566	90	THIOUREA
91087	90	TOLUENEDIISOCYANATEA
584849	90	TOLUENEDIISOCYANATEB
26471625	90	TOLUENEDIISOCYANATEC

Chemical Group: MontrealProtocol

76142	91	DICHLOROTETRAFLUORO-ETHANE(CFC-114)
76153	91	MONOCHLOROPENTA-FLUOROETHANE(CFC-115)
124732	91	DIBROMOTETRAFLUORO-ETHANE(HALON 2402)
353593	92	BROMOCHLORODIFLUORO-METHANE(HALON1211)
74839	90	BROMOMETHANE
56235	90	CARBONTETRACHLORIDE
75718	91	DICHLORODI-FLUOROMETHANE
76131	90	FREON113
71556	90	TRICHLOROETHANEA
75694	91	TRICHLOROMONO-FLUOROMETHANE
75638	91	TRIFLUOROBROMO-METHANE

Chemical Group: Both Processed and Otherwise Used Chemicals

67641	90	ACETONE
75092	90	DICHLOROMETHANE
76131	90	FREON113
1022	90	GLYCOLETHERS
67561	90	METHANOL
78933	90	METHYLETHYLKETONE
108883	90	TOLUENE
71556	90	TRICHLOROETHANEA
79016	90	TRICHLOROETHYLENE
1330207	90	XYLENEMIXEDISOMER

Chemical Group: Processed Chemicals

117817	90	DIETHYLHEXYLPHT
107211	90	ETHYLENEGLYCOL
50000	90	FORMALDEHYDE
109864	90	METHOXYETHANOL
101688	90	METHYLENEBISPHENYL
108101	90	METHYLISOBUTYLKETO
80626	90	METHYLMETHACRYLATE
91203	90	NAPHTHALENE
108952	90	PHENOL
85449	90	PHTHALICANHYDRIDE
100425	90	STYRENEMONOMER
26471625	90	TOLUENEDIISOCYANATEC

Chemical Group: Swedish Chemical List

7439976	90	MERCURY
7440382	90	ARSENIC
1001	90	ARSENIC COMPOUNDS
353593	92	BROMOCHLORODIFLUORO-METHANE(HALON1211)
85687	90	BUTYLBENZYLPHTHALA
84742	90	BUTYLPHTHALATE
7440439	90	CADMIUM
1004	90	CADMIUM COMPOUNDS
8001589	90	CREOSOTE
75092	90	DICHLOROMETHANE
117817	90	DIETHYLHEXYLPHT
84662	90	DIETHYLPHTHALATE
117840	90	DIOCTYLPHTHALATE
7439921	90	LEAD
7758976	93	LEADCHROMATE
1026	90	LEAD COMPOUNDS
85449	90	PHTHALICANHYDRIDE
127184	90	TETRACHLOROETHYLENE
79016	90	TRICHLOROETHYLENE

Chemical Group: US EPA 33/50 Chemicals

71432	90	BENZENE
7439976	90	MERCURY
7440439	90	CADMIUM
1004	90	CADMIUM COMPOUNDS
56235	90	CARBONTETRACHLORIDE
67663	90	CHLOROFORM
7440473	90	CHROMIUM
1012	90	CHROMIUM & COMPOUNDS
1016	90	CYANIDE COMPOUNDS
75092	90	DICHLOROMETHANE
7439921	90	LEAD
1026	90	LEAD COMPOUNDS
78933	90	METHYLETHYLKETONE
108101	90	METHYLISOBUTYLKETO
7440020	90	NICKEL
1029	90	NICKEL AND COMPOUNDS
127184	90	TETRACHLOROETHYLENE
108883	90	TOLUENE
71556	90	TRICHLOROETHANEA
79016	90	TRICHLOROETHYLENE
106423	90	XYLENEC
1330207	90	XYLENEMIXEDISOMER

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CAS#	Name	Year added to TURA List
	ANTIMONY COMPOUNDS	1990
	ARSENIC COMPOUNDS	1990
	BARIUM COMPOUNDS	1990
	BERYLLIUM COMPOUNDS	1990
	CADMIUM COMPOUNDS	1990
	CHLORDANE (TECHNICAL MIXTURE AND METABOLITES)	1993
	CHLORINATED BENZENES	1993
	CHLORINATED ETHANES	1993
	CHLORINATED NAPHTHALENE	1993
	CHLORINATED PHENOLS	1990
	CHLOROALKYL ETHERS	1993
	CHLOROPHENOLS	1990
	CHROMIUM COMPOUNDS	1990
	COBALT COMPOUNDS	1990
	COKE OVEN EMISSIONS	1993
	COPPER COMPOUNDS	1990
	CYANIDE COMPOUNDS	1990
	DDT AND METABOLITES	1993
	DICHLOROBENZIDINE	1993
	DIPHENYLHYDRAZINE	1993
	ENDOSULFAN AND METABOLITES	1993
	ENDRIN AND METABOLITES	1993
	GLYCOL ETHERS	1990
	HALOETHERS	1993
	HALOMETHANES	1993
	HEPTACHLOR AND METABOLITES	1993
	LEAD COMPOUNDS	1990
	MANGANESE COMPOUNDS	1990
	MERCURY COMPOUNDS	1990
	NICKEL COMPOUNDS	1990
	NITROPHENOLS	1993
	NITROSAMINES	1993
	PHTHALATE ESTERS	1993
	POLYBROMINATED BIPHENYLS (PBBS)	1990
	POLYNUCLEAR AROMATIC HYDROCARBONS	1993
	SELENIUM COMPOUNDS	1990
	SILVER COMPOUNDS	1990
	THALLIUM COMPOUNDS	1990
	ZINC COMPOUNDS	1990
50-00-0	FORMALDEHYDE	1990
50-07-7	MITOMYCIN C	1991
50-18-0	CYCLOPHOSPHAMIDE	1991
50-29-3	DDT	1991
50-32-8	BENZO[A]PYRENE	1991
50-55-5	RESERPINE	1991
51-28-5	2,4-DINITROPHENOL	1990
51-43-4	EPINEPHRINE	1991
51-75-2	MECHLORETHAMINE	1990
51-75-2	NITROGEN MUSTARD	1990
51-79-6	CARBAMIC ACID, ETHYL ESTER	1990
51-79-6	ETHYL CARBAMATE	1990
51-79-6	URETHANE	1990
52-68-6	TRICHLORFON	1990
52-85-7	FAMPHUR	1991
53-70-3	DIBENZ[A,H]ANTHRACENE	1991
53-96-3	2-ACETYLAMINOFLUORENE	1990
54-11-5	NICOTINE	1991
54-11-5	NICOTINE AND SALTS	1991
54-11-5	PYRIDINE, 3-(1-METHYL-2-PYRROLIDINYL) -,(S)-	1991
55-18-5	N-NITROSODIETHYLAMINE	1990
55-21-0	BENZAMIDE	1990
55-63-0	NITROGLYCERIN	1990
55-91-4	DIISOPROPYLFLUOROPHOSPHATE	1991
55-91-4	ISOFLUORPHATE	1991
56-04-2	METHYLTHIOURACIL	1991
56-23-5	CARBON TETRACHLORIDE	1990
56-38-2	PARATHION	1990
56-49-5	3-METHYLCHOLANTHRENE	1991
56-53-1	DIETHYLSTILBESTROL	1991
56-55-3	BENZ[A]ANTHRACENE	1991
56-72-4	COUMAPHOS	1991
57-12-5	CYANIDES (SOLUBLE SALTS AND COMPLEXES)	1991
57-14-7	1,1-DIMETHYL HYDRAZINE	1990
57-14-7	DIMETHYLHYDRAZINE	1990
57-14-7	HYDRAZINE, 1,1-DIMETHYL-	1990
57-24-9	STRYCHNINE	1991
57-24-9	STRYCHNINE, & SALTS	1991
57-57-8	BETA-PROPIOLACTONE	1990
57-74-9	CHLORDANE	1990
57-97-6	7,12-DIMETHYLBENZ[A]ANTHRACENE	1991
58-89-9	HEXACHLOROCYCLOHEXANE (GAMMA ISOMER)	1990
58-89-9	LINDANE	1990
58-90-2	2,3,4,6-TETRACHLOROPHENOL	1991
59-50-7	P-CHLORO-M-CRESOL	1991
59-89-2	N-NITROSOMORPHOLINE	1990
60-00-4	ETHYLENEDIAMINE-TETRAACETIC ACID (EDTA)	1991
60-09-3	4-AMINOAZOBENZENE	1990
60-11-7	4-DIMETHYLAMINOAZOBENZENE	1990
60-11-7	DIMETHYLAMINOAZOBENZENE	1990
60-29-7	ETHYL ETHER	1991
60-34-4	METHYL HYDRAZINE	1990
60-35-5	ACETAMIDE	1990
60-51-5	DIMETHOATE	1991
60-57-1	DIELDRIN	1991
61-82-5	AMITROLE	1991

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CAS#	Name	Year added to TURA List
62-38-4	PHENYLMERCURIC ACETATE	1991
62-38-4	PHENYLMERCURY ACETATE	1991
62-44-2	PHENACETIN	1991
62-50-0	ETHYL METHANESULFONATE	1991
62-53-3	ANILINE	1990
62-55-5	THIOACETAMIDE	1990
62-56-6	THIOUREA	1990
62-73-7	OICHLORVOS	1990
62-74-8	FLUOROACETIC ACIO, SOOIUM SALT	1991
62-74-8	SOOIUM FLUOROACETATE	1991
62-75-9	METHANAMINE, N-METHYL-N-NITROSO-	1990
62-75-9	N-NITROSOOIMETHYLAMINE	1990
62-75-9	NITROSOOIMETHYLAMINE	1990
63-25-2	CARBARYL	1990
64-18-6	FORMIC ACIO	1991
64-19-7	ACETIC ACIO	1991
64-67-5	OIETHYL SULFATE	1990
65-85-0	BENZOIC ACIO	1991
66-75-1	URACIL MUSTARO	1991
67-56-1	METHANOL	1990
67-63-0	ISOPROPYL ALCOHOL (MFG-STRONG ACIO PROCESS)	1990
67-64-1	ACETONE	1990
67-66-3	CHLOROFORM	1990
67-72-1	HEXACHLOROETHANE	1990
68-76-8	TRIAZIQUONE	1990
70-25-7	GUANIOINE, N-METHYL-N'-NITRO-N-NITROSO-	1991
70-30-4	HEXACHLOROPHENE	1991
71-36-3	N-BUTYL ALCOHOL	1990
71-43-2	BENZENE	1990
71-55-6	METHYL CHLOROFORM	1990
71-55-6	1,1,1-TRICHLOROETHANE	1990
72-20-8	ENDRIN	1991
72-43-5	METHOXYCHLOR	1990
72-54-8	000	1991
72-55-9	OOE	1991
72-57-1	TRYPAN BLUE	1991
74-83-9	BROMOMETHANE	1990
74-83-9	METHYL BROMIOE	1990
74-85-1	ETHYLENE	1990
74-87-3	CHLOROMETHANE	1990
74-87-3	METHYL CHLORIOE	1990
74-88-4	METHYL IOOIOE	1990
74-89-5	MONOMETHYLAMINE	1991
74-90-8	HYOROCYANIC ACID	1990
74-90-8	HYOROGEN CYANIOE	1990
74-93-1	METHYL MERCAPTAN	1991
74-93-1	THIOMETHANOL	1991
74-95-3	METHYLENE BROMIDE	1990
75-00-3	CHLOROETHANE	1990
75-00-3	ETHYL CHLORIOE	1990
75-01-4	VINYL CHLORIDE	1990
75-04-7	MONOETHYLAMINE	1991
75-05-8	ACETONITRILE	1990
75-07-0	ACETALDEHYOE	1990
75-09-2	OICHLOROMETHANE	1990
75-09-2	METHYLENE CHLORIOE	1990
75-15-0	CARBON OISULFIOE	1990
75-20-7	CALCIUM CARBIOE	1991
75-21-8	ETHYLENE OXIOE	1990
75-21-8	OXIRANE	1990
75-25-2	BROMOFORM	1990
75-25-2	TRIBROMOMETHANE	1990
75-27-4	OICHLOROBROMOMETHANE	1990
75-34-3	1,1-OICHLOROETHANE	1991
75-35-4	1,1-OICHLOROETHYLENE	1990
75-35-4	VINYLIDENE CHLORIOE	1990
75-36-5	ACETYL CHLORIOE	1991
75-44-5	PHOSGENE	1990
75-50-3	TRIMETHYLAMINE	1991
75-55-8	AZIRIDINE, 2-METHYL	1990
75-55-8	PROPYLENEIMINE	1990
75-56-9	PROPYLENE OXIOE	1990
75-60-5	CACODYLIC ACIO	1991
75-63-8	BROMOTRIFLUOROMETHANE (HALON 1301)	1991
75-63-8	HALON 1301	1991
75-64-9	TERT-BUTYLAMINE	1991
75-65-0	TERT-BUTYL ALCOHOL	1990
75-69-4	CFC-11	1991
75-69-4	TRICHLOROFLUOROMETHANE (CFC-11)	1991
75-69-4	TRICHLOROMONOFLUOROMETHANE	1991
75-71-8	CFC-12	1991
75-71-8	OICHLORODIFLUOROMETHANE (CFC-12)	1991
75-86-5	ACETONE CYANOHYORIN	1991
75-87-6	ACETALDEHYDE, TRICHLORO-	1991
75-99-0	2,2-OICHLOROPROPIONIC ACIO	1991
76-01-7	PENTACHLOROETHANE	1991
76-13-1	FREON 113	1990
76-14-2	CFC-114	1991
76-14-2	OICHLOROTETRAFLUOROETHANE (CFC-114)	1991
76-15-3	CFC-115	1991
76-15-3	MONOCHLOROPENTAFLUOROETHANE (CFC-115)	1991
76-44-8	HEPTACHLOR	1990
77-47-4	HEXACHLOROCYCLOPENTAOIENE	1990
77-78-1	DIMETHYL SULFATE	1990
78-00-2	TETRAETHYL LEAO	1991
78-59-1	ISOPHORONE	1991

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78-79-5	ISOPRENE	1991
78-81-9	ISO-BUTYLAMINE	1991
78-83-1	ISOBUTYL ALCOHOL	1991
78-84-2	ISOBUTYRALDEHYDE	1990
78-87-5	1,2-DICHLOROPROPANE	1990
78-87-5	PROPANE 1,2-DICHLORO-	1990
78-88-6	2,3-DICHLOROPROPENE	1990
78-92-2	SEC-BUTYL ALCOHOL	1990
78-93-3	METHYL ETHYL KETONE	1990
78-93-3	METHYL ETHYL KETONE (MEK)	1990
78-99-9	1,1-DICHLOROPROPANE	1991
79-00-5	1,1,2-TRICHLOROETHANE	1990
79-01-6	TRICHLOROETHYLENE	1990
79-06-1	ACRYLAMIDE	1990
79-09-4	PROPIONIC ACID	1991
79-10-7	ACRYLIC ACID	1990
79-11-8	CHLOROACETIC ACID	1990
79-19-6	THIOSEMICARBAZIDE	1991
79-21-0	PERACETIC ACID	1990
79-22-1	METHYL CHLOROFORMATE	1991
79-31-2	ISO-BUTYRIC ACID	1991
79-34-5	1,1,2,2-TETRACHLOROETHANE	1990
79-44-7	DIMETHYLCARBAMYL CHLORIDE	1990
79-46-9	2-NITROPROPANE	1990
80-05-7	4,4'-ISOPROPYLIDENEDIPHENOL	1990
80-15-9	CUMENE HYDROPEROXIDE	1990
80-15-9	HYDROPEROXIDE, 1-METHYL-1-PHENYLETHYL-	1990
80-62-6	METHYL METHACRYLATE	1990
81-07-2	SACCHARIN (MANUFACTURING)	1990
81-07-2	SACCHARIN AND SALTS	1991
81-81-2	WARFARIN	1991
81-81-2	WARFARIN, & SALTS, CONC.>0.3%	1991
81-88-9	C.I. FOOD RED 15	1990
82-28-0	1-AMINO-2-METHYLANTHRAQUINONE	1990
82-68-8	PCNB	1990
82-68-8	PENTACHLORONITROBENZENE	1990
82-68-8	QUINTOZENE	1990
83-32-9	ACENAPHTHENE	1991
84-66-2	DIETHYL PHTHALATE	1990
84-74-2	N-BUTYL PHTHALATE	1990
84-74-2	DIBUTYL PHTHALATE	1990
85-00-7	DIQUAT	1991
85-01-8	PHENANTHRENE	1991
85-44-9	PHTHALIC ANHYDRIDE	1990
85-68-7	BUTYL BENZYL PHTHALATE	1990
86-30-6	N-NITROSODIPHENYLAMINE	1990
86-50-0	AZINPHOS-METHYL	1991
86-50-0	GUTHION	1991
86-73-7	FLUORENE	1991
86-88-4	ANTU	1991
86-88-4	THIOUREA, 1-NAPHTHALENYL-	1991
87-62-7	2,6-XYLIDINE	1990
87-65-0	2,6-DICHLOROPHENOL	1991
87-68-3	HEXACHLORO-1,3-BUTADIENE	1990
87-68-3	HEXACHLOROBUTADIENE	1990
87-86-5	PCP	1990
87-86-5	PENTACHLOROPHENOL	1990
88-06-2	2,4,6-TRICHLOROPHENOL	1990
88-72-2	O-NITROTOLUENE	1991
88-75-5	2-NITROPHENOL	1990
88-85-7	DINOSEB	1991
88-89-1	PICRIC ACID	1990
90-04-0	O-ANISIDINE	1990
90-43-7	2-PHENYLPHENOL	1990
90-94-8	MICHLER'S KETONE	1990
91-08-7	TOLUENE 2,6-DIISOCYANATE	1990
91-20-3	NAPHTHALENE	1990
91-22-5	QUINOLINE	1990
91-58-7	2-CHLORONAPHTHALENE	1991
91-59-8	BETA-NAPHTHYLAMINE	1990
91-80-5	METHAPYRILENE	1991
91-94-1	3,3'-DICHLOROBENZIDINE	1990
92-52-4	BIPHENYL	1990
92-67-1	4-AMINOBIPHENYL	1990
92-87-5	BENZIDINE	1990
92-93-3	4-NITROBIPHENYL	1990
93-72-1	SILVEX (2,4,5-TP)	1991
93-76-5	2,4,5-T ACID	1991
93-79-8	2,4,5-T ESTERS	1991
94-11-1	2,4-D ESTERS	1991
94-36-0	BENZOYL PEROXIDE	1990
94-58-6	DIHYDROSAFROLE	1991
94-59-7	SAFROLE	1990
94-75-7	2,4-D	1990
94-75-7	2,4-D ACID	1990
94-75-7	2,4-D, SALTS AND ESTERS	1991
94-79-1	2,4-D ESTERS	1991
94-80-4	2,4-D ESTERS	1991
95-47-6	BENZENE, O-DIMETHYL-	1990
95-47-6	O-XYLENE	1990
95-48-7	O-CRESOL	1990
95-50-1	1,2-DICHLOROBENZENE	1990
95-50-1	O-DICHLOROBENZENE	1990
95-53-4	O-TOLUIDINE	1990
95-57-8	2-CHLOROPHENOL	1991
95-63-6	1,2,4-TRIMETHYLBENZENE	1990
95-80-7	2,4-DIAMINOTOLUENE	1990
95-94-3	1,2,4,5-TETRACHLOROBENZENE	1991
95-95-4	2,4,5-TRICHLOROPHENOL	1990
96-09-3	STYRENE OXIDE	1990
96-12-8	DBCP	1990

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CAS#	Name	Year added to TURA List
96-12-8	1,2-DIBROMO-3-CHLOROPROPANE	1990
96-33-3	METHYL ACRYLATE	1990
96-45-7	ETHYLENE THIOUREA	1990
97-56-3	C.I. SOLVENT YELLOW 3	1990
97-63-2	ETHYL METHACRYLATE	1991
98-01-1	FURFURAL	1991
98-07-7	BENZOIC TRICHLORIDE	1990
98-07-7	BENZOTRICHLORIDE	1990
98-09-9	BENZENESULFONYL CHLORIDE	1991
98-82-8	CUMENE	1990
98-86-2	ACETOPHENONE	1991
98-87-3	BENZAL CHLORIDE	1990
98-88-4	BENZOYL CHLORIDE	1990
98-95-3	NITROBENZENE	1990
99-08-1	M-NITROTOLUENE	1991
99-35-4	1,3,5-TRINITROBENZENE	1991
99-55-8	5-NITRO-O-TOLUIDINE	1991
99-59-2	5-NITRO-O-ANISIDINE	1990
99-65-0	M-DINITROBENZENE	1990
99-99-0	P-NITROTOLUENE	1991
100-01-6	P-NITROANILINE	1991
100-02-7	4-NITROPHENOL	1990
100-02-7	P-NITROPHENOL	1990
100-25-4	P-DINITROBENZENE	1990
100-41-4	ETHYLBENZENE	1990
100-42-5	STYRENE	1990
100-44-7	BENZYL CHLORIDE	1990
100-47-0	BENZONITRILE	1991
100-75-4	N-NITROSOPIPERIDINE	1990
101-14-4	MBOCA	1990
101-14-4	4,4'-METHYLENEBIS(2-CHLOROANILINE)	1990
101-55-3	4-BROMOPHENYL PHENYL ETHER	1991
101-61-1	4,4'-METHYLENEBIS(N, N-DIMETHYL)BENZENAMINE	1990
101-68-8	MBI	1990
101-68-8	METHYLENEBIS(PHENYLISOCYANATE)	1990
101-77-9	4,4'-METHYLENEDIANILINE	1990
101-80-4	4,4'-DIAMINODIPHENYL ETHER	1990
103-23-1	BIS(2-ETHYLHEXYL) ADIPATE	1990
103-85-5	PHENYLTHIOUREA	1991
104-94-9	P-ANISIDINE	1990
105-46-4	SEC-BUTYL ACETATE	1991
105-67-9	2,4-DIMETHYLPHENOL	1990
106-42-3	BENZENE, P-DIMETHYL-	1990
106-42-3	P-XYLENE	1990
106-44-5	P-CRESOL	1990
106-46-7	1,4-DICHLOROBENZENE	1990
106-47-8	P-CHLOROANILINE	1991
106-49-0	P-TOLUIDINE	1991
106-50-3	P-PHENYLENEDIAMINE	1990
106-51-4	P-BENZOQUINONE	1990
106-51-4	QUINONE	1990
106-88-7	1,2-BUTYLENE OXIDE	1990
106-89-8	EPICHLOROHYDRIN	1990
106-93-4	1,2-DIBROMOETHANE	1990
106-93-4	ETHYLENE DIBROMIDE	1990
106-99-0	1,3-BUTADIENE	1990
107-02-8	ACROLEIN	1990
107-05-1	ALLYL CHLORIDE	1990
107-06-2	1,2-DICHLOROETHANE	1990
107-06-2	ETHYLENE DICHLORIDE	1990
107-10-8	N-PROPYLAMINE	1991
107-12-0	ETHYL CYANIDE	1991
107-12-0	PROPIONITRILE	1991
107-13-1	ACRYLONITRILE	1990
107-15-3	ETHYLENEDIAMINE	1991
107-18-6	ALLYL ALCOHOL	1990
107-19-7	PROPARGYL ALCOHOL	1991
107-20-0	CHLOROACETALDEHYDE	1991
107-21-1	ETHYLENE GLYCOL	1990
107-30-2	CHLOROMETHYL METHYL ETHER	1990
107-49-3	TEPP	1991
107-49-3	TETRAETHYL PYROPHOSPHATE	1991
107-92-6	BUTYRIC ACID	1991
108-05-4	VINYL ACETATE	1990
108-05-4	VINYL ACETATE MONOMER	1990
108-10-1	METHYL ISOBUTYL KETONE	1990
108-24-7	ACETIC ANHYDRIDE	1991
108-31-6	MALEIC ANHYDRIDE	1990
108-38-3	BENZENE, M-DIMETHYL-	1990
108-38-3	M-XYLENE	1990
108-39-4	M-CRESOL	1990
108-46-3	RESORCINOL	1991
108-60-1	BIS(2-CHLORO-1-METHYLETHYL)ETHER	1990
108-60-1	DICHLOROISOPROPYL ETHER	1990
108-88-3	TOLUENE	1990
108-90-7	CHLOROBENZENE	1990
108-94-1	CYCLOHEXANONE	1991
108-95-2	PHENOL	1990
108-98-5	BENZENETHIOL	1991
108-98-5	THIOPHENOL	1991
109-06-8	2-PICOLINE	1991
109-73-9	BUTYLAMINE	1991
109-77-3	MALONONITRILE	1991
109-86-4	2-METHOXYETHANOL	1990
109-89-7	DIETHYLAMINE	1991
109-99-9	FURAN, TETRAHYDRO-	1991
110-00-9	FURAN	1991
110-16-7	MALEIC ACID	1991
110-17-8	FUMARIC ACID	1991
110-19-0	ISO-BUTYL ACETATE	1991
110-75-8	2-CHLOROETHYL VINYL ETHER	1991

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110-80-5	ETHANOL, 2-ETHOXY-	1990
110-80-5	2-ETHOXYETHANOL	1990
110-82-7	CYCLOHEXANE	1990
110-86-1	PYRIDINE	1990
111-42-2	DIETHANOLAMINE	1990
111-44-4	BIS(2-CHLOROETHYL) ETHER	1990
111-44-4	DICHLOROETHYL ETHER	1990
111-54-6	ETHYLENEBISDITHIOCARBAMIC ACID, SALTS & ESTERS	1991
111-91-1	BIS(2-CHLOROETHOXY) METHANE	1991
114-26-1	PROPOXUR	1990
115-02-6	AZASERINE	1991
115-07-1	PROPYLENE (PROPENE)	1990
115-29-7	ENDOSULFAN	1991
115-32-2	DICOFOL	1990
116-06-3	ALDICARB	1991
117-79-3	2-AMINOANTHRAQUINONE	1990
117-80-6	DICHLONE	1991
117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	1990
117-81-7	DEHP	1990
117-81-7	DI(2-ETHYLHEXYL) PHTHALATE	1990
117-84-0	N-DIOCTYLPHTHALATE	1990
117-84-0	DI-N-OCTYL PHTHALATE	1990
118-74-1	HEXACHLOROBENZENE	1990
119-90-4	3,3'-DIMETHOXYBENZIDINE	1990
119-93-7	3,3'-DIMETHYLBENZIDINE	1990
119-93-7	O-TOLIDINE	1990
120-12-7	ANTHRACENE	1990
120-58-1	ISOSAFROLE	1990
120-71-8	P-CRESIDINE	1990
120-80-9	CATECHOL	1990
120-82-1	1,2,4-TRICHLOROBENZENE	1990
120-83-2	2,4-DICHLOROPHENOL	1990
121-14-2	2,4-DINITROTOLUENE	1990
121-21-1	PYRETHRINS	1991
121-29-9	PYRETHRINS	1991
121-44-8	TRIETHYLAMINE	1991
121-69-7	N, N-DIMETHYLANILINE	1990
121-75-5	MALATHION	1991
122-09-8	BENZENEETHANAMINE, ALPHA, ALPHA-DIMETHYL-	1991
122-66-7	1,2-DIPHENYLHYDRAZINE	1990
122-66-7	HYDRAZINE, 1,2-DIPHENYL-	1990
122-66-7	HYDRAZOBENZENE	1990
123-31-9	HYDROQUINONE	1990
123-33-1	MALEIC HYDRAZIDE	1991
123-38-6	PROPIONALDEHYDE	1990
123-62-6	PROPIONIC ANHYDRIDE	1991
123-63-7	PARALDEHYDE	1991
123-72-8	BUTYRALDEHYDE	1990
123-73-9	CROTONALDEHYDE, (E)-	1991
123-86-4	BUTYL ACETATE	1991
123-91-1	1,4-DIOXANE	1990
123-92-2	ISO-AMYL ACETATE	1991
124-04-9	ADIPIC ACID	1991
124-40-3	DIMETHYLAMINE	1991
124-41-4	SODIUM METHYLATE	1991
124-48-1	CHLORODIBROMOMETHANE	1991
124-73-2	DIBROMOTETRAFLUOROETHANE (HALON 2402)	1991
124-73-2	HALON 2402	1991
126-72-7	TRIS(2,3-DIBROMOPROPYL) PHOSPHATE	1990
126-98-7	METHACRYLONITRILE	1991
126-99-8	CHLOROPRENE	1990
127-18-4	PERCHLOROETHYLENE	1990
127-18-4	TETRACHLOROETHYLENE	1990
127-82-2	ZINC PHENOLSULFONATE	1991
128-66-5	C.I. VAT YELLOW 4	1990
129-00-0	PYRENE	1991
130-15-4	1,4-NAPHTHOQUINONE	1991
131-11-3	DIMETHYL PHTHALATE	1990
131-74-8	AMMONIUM PICRATE	1991
131-89-5	2-CYCLOHEXYL-4,6-DINITROPHENOL	1991
132-64-9	DIBENZOFURAN	1990
133-06-2	CAPTAN	1990
133-90-4	CHLORAMBEN	1990
134-29-2	O-ANISIDINE HYDROCHLORIDE	1990
134-32-7	ALPHA-NAPHTHYLAMINE	1990
135-20-6	CUPFERRON	1990
137-26-8	THIRAM	1991
139-13-9	NITRILOTRIACETIC ACID	1990
139-65-1	4,4'-THIODIANILINE	1990
140-88-5	ETHYL ACRYLATE	1990
141-32-2	BUTYL ACRYLATE	1990
141-78-6	ETHYL ACETATE	1991
142-28-9	1,3-DICHLOROPROPANE	1991
142-71-2	CUPRIC ACETATE	1991
142-84-7	DIPROPYLAMINE	1991
143-33-9	SODIUM CYANIDE NA(CN)	1991
143-50-0	KEPONE	1991
145-73-3	ENDOTHALL	1991
148-82-3	MELPHALAN	1991
151-50-8	POTASSIUM CYANIDE	1991
151-56-4	AZIRIDINE	1990
151-56-4	ETHYLENEIMINE	1990
152-16-9	DIPHOSPHORAMIDE, OCTAMETHYL-	1991
156-10-5	P-NITROSODIPHENYLAMINE	1990
156-60-5	1,2-DICHLOROETHYLENE	1991
156-62-7	CALCIUM CYANAMIDE	1990
189-55-9	DIBENZ[A,I]PYRENE	1991

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191-24-2	BENZO(GHI)PERYLENE	1991
193-39-5	INDENO(1,2,3-CD)PYRENE	1991
205-99-2	BENZO(B)FLUORANTHENE	1992
206-44-0	FLUORANTHENE	1992
207-08-9	BENZO(K)FLUORANTHENE	1992
208-96-8	ACENAPHTHYLENE	1992
218-01-9	CHRYSENE	1992
225-51-4	BENZ(C)ACRIDINE	1992
297-97-2	O,O-DIETHYL O-PYRAZINYL PHOSPHOROTHIOATE	1992
297-97-2	THIONAZIN	1992
298-00-0	METHYL PARATHION	1992
298-00-0	PARATHION-METHYL	1992
298-02-2	PHORATE	1992
298-04-4	DISULFOTON	1992
300-76-5	NALED	1992
301-04-2	LEAD ACETATE	1992
302-01-2	HYDRAZINE	1990
303-34-4	LASIOCARPINE	1992
305-03-3	CHLORAMBUCIL	1992
309-00-2	ALDRIN	1990
311-45-5	DIETHYL-P-NITROPHENYL PHOSPHATE	1992
315-18-4	MEXACARBATE	1992
319-84-6	ALPHA-BHC	1992
319-85-7	BETA-BHC	1992
319-86-8	DELTA-BHC	1992
329-71-5	2,5-DINITROPHENOL	1992
330-54-1	DIURON	1992
333-41-5	DIAZINON	1992
334-88-3	DIAZOMETHANE	1990
353-50-4	CARBONIC DIFLUORIDE	1992
353-59-3	BROMOCHLORODIFLUOROMETHANE (HALON 1211)	1992
353-59-3	HALON 1211	1992
357-57-3	BRUCINE	1992
460-19-5	CYANOGEN	1992
463-58-1	CARBONYL SULFIDE	1990
465-73-6	ISODRIN	1992
492-80-8	AURAMINE	1990
492-80-8	C.I. SOLVENT YELLOW 34	1990
494-03-1	CHLORNAPHAZINE	1992
496-72-0	DIAMINOTOLUENE	1992
504-24-5	4-AMINOPYRIDINE	1992
504-24-5	PYRIDINE, 4-AMINO-	1992
504-60-9	1,3-PENTADIENE	1992
505-60-2	MUSTARD GAS	1990
506-61-6	POTASSIUM SILVER CYANIDE	1992
506-64-9	SILVER CYANIDE	1992
506-68-3	CYANOGEN BROMIDE	1992
506-77-4	CYANOGEN CHLORIDE	1992
506-87-6	AMMONIUM CARBONATE	1992
506-96-7	ACETYL BROMIDE	1992
509-14-8	TETRANITROMETHANE	1992
510-15-6	CHLOROBENZILATE	1990
513-49-5	SEC-BUTYLAMINE	1992
528-29-0	O-DINITROBENZENE	1990
532-27-4	2-CHLOROACETOPHENONE	1990
534-52-1	4,6-DINITRO-O-CRESOL	1990
534-52-1	4,6-DINITRO-O-CRESOL AND SALTS	1992
534-52-1	DINITROCRESOL	1992
540-59-0	1,2-DICHLOROETHYLENE	1990
540-73-8	HYDRAZINE, 1,2-DIMETHYL-	1992
540-88-5	TERT-BUTYL ACETATE	1992
541-09-3	URANYL ACETATE	1992
541-41-3	ETHYL CHLOROFORMATE	1990
541-53-7	DITHIOBIURET	1992
541-73-1	1,3-DICHLOROBENZENE	1990
542-62-1	BARIUM CYANIDE	1992
542-75-6	1,3-DICHLOROPROPENE	1990
542-75-6	1,3-DICHLOROPROPYLENE	1990
542-76-7	3-CHLOROPROPIONITRILE	1992
542-76-7	PROPIONITRILE, 3-CHLORO-	1992
542-88-1	BIS(CHLOROMETHYL) ETHER	1990
542-88-1	CHLOROMETHYL ETHER	1990
542-88-1	DICHLOROMETHYL ETHER	1990
543-90-8	CADMIUM ACETATE	1992
544-18-3	COBALTOUS FORMATE	1992
544-92-3	COPPER CYANIDE	1992
554-84-7	M-NITROPHENOL	1992
557-19-7	NICKEL CYANIDE	1992
557-21-1	ZINC CYANIDE	1992
557-34-6	ZINC ACETATE	1992
557-41-5	ZINC FORMATE	1992
563-12-2	ETHION	1992
563-68-8	THALLIUM(I) ACETATE	1992
569-64-2	C.I. BASIC GREEN 4	1990
573-56-8	2,6-DINITROPHENOL	1992
584-84-9	TOLUENE-2,4-DIISOCYANATE	1990
591-08-2	1-ACETYL-2-THIOUREA	1992
592-01-8	CALCIUM CYANIDE	1992
592-04-1	MERCURIC CYANIDE	1992
592-85-8	MERCURIC THIOCYANATE	1992
592-87-0	LEAD THIOCYANATE	1992
593-60-2	VINYL BROMIDE	1990
594-42-3	PERCHLOROMETHYLMERCAPTAN	1992
594-42-3	TRICHLOROMETHANESULFENYL CHLORIDE	1992
598-31-2	BROMOACETONE	1992
606-20-2	2,6-DINITROTOLUENE	1990
608-93-5	PENTACHLOROBENZENE	1992
609-19-8	3,4,5-TRICHLOROPHENOL	1992
610-39-9	3,4-DINITROTOLUENE	1992
615-05-4	2,4-DIAMINOANISOLE	1990

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615-53-2	N-NITROSO-N-METHYLURETHANE	1992
621-64-7	OI-N-PROPYLNITROSAMINE	1990
621-64-7	N-NITROSODI-N-PROPYLAMINE	1990
624-83-9	METHYL ISOCYANATE	1990
625-16-1	TERT-AMYL ACETATE	1992
626-38-0	SEC-AMYL ACETATE	1992
628-63-7	AMYL ACETATE	1992
628-86-4	MERCURY FULMINATE	1992
630-10-4	SELENOUREA	1992
630-20-6	ETHANE, 1,1,1,2-TETRACHLORO-	1992
631-61-8	AMMONIUM ACETATE	1992
636-21-5	O-TOLUIDINE HYDROCHLORIDE	1990
640-19-7	FLUOROACETAMIDE	1992
680-31-9	HEXAMETHYLPHOSPHORAMIDE	1990
684-93-5	N-NITROSO-N-METHYLUREA	1990
692-42-2	DIETHYLARSINE	1992
696-28-6	DICHLOROPHENYLARSINE	1992
696-28-6	PHENYL DICHLOROARSINE	1992
757-58-4	HEXAETHYL TETRAPHOSPHATE	1992
759-73-9	N-NITROSO-N-ETHYLUREA	1990
764-41-0	2-BUTENE, 1,4-DICHLORO-	1992
765-34-4	GLYCIDYLALDEHYDE	1992
815-82-7	CUPRIC TARTRATE	1992
823-40-5	DIAMINOTOLUENE	1992
842-07-9	C.I. SOLVENT YELLOW 14	1990
924-16-3	N-NITROSODI-N-BUTYLAMINE	1990
930-55-2	N-NITROSOPYRROLIDINE	1992
933-75-5	2,3,6-TRICHLOROPHENOL	1992
933-78-8	2,3,5-TRICHLOROPHENOL	1992
959-98-8	ALPHA-ENDOSULFAN	1992
961-11-5	TETRACHLORVINPHOS	1990
989-38-8	C.I. BASIC RED 1	1990
1024-57-3	HEPTACHLOR EPOXIDE	1992
1031-07-8	ENDOSULFAN SULFATE	1992
1066-30-4	CHROMIC ACETATE	1992
1066-33-7	AMMONIUM BICARBONATE	1992
1072-35-1	LEAD STEARATE	1992
1111-78-0	AMMONIUM CARBAMATE	1992
1116-54-7	N-NITROSODIETHANOLAMINE	1992
1120-71-4	1,3-PROPANE SULTONE	1990
1120-71-4	PROPANE SULTONE	1990
1163-19-5	DECABROMODIPHENYL OXIDE	1990
1185-57-5	FERRIC AMMONIUM CITRATE	1992
1194-65-6	DICHLOBENIL	1992
1300-71-6	XYLENOL	1992
1303-28-2	ARSENIC PENTOXIDE	1992
1303-32-8	ARSENIC DISULFIDE	1992
1303-33-9	ARSENIC TRISULFIDE	1992
1309-64-4	ANTIMONY TRIOXIDE	1992
1310-58-3	POTASSIUM HYDROXIDE	1992
1310-73-2	SODIUM HYDROXIDE	1992
1313-27-5	MOLYBDENUM TRIOXIDE	1990
1314-20-1	THORIUM DIOXIDE	1990
1314-32-5	THALLIC OXIDE	1992
1314-62-1	VANADIUM PENTOXIDE	1992
1314-80-3	SULFUR PHOSPHIDE	1992
1314-84-7	ZINC PHOSPHIDE	1992
1314-84-7	ZINC PHOSPHIDE (CONC. <= 10%)	1992
1314-84-7	ZINC PHOSPHIDE (CONC. > 10%)	1992
1314-87-0	LEAD SULFIDE	1992
1319-72-8	2,4,5-T AMINES	1992
1319-77-3	CRESOL (MIXED ISOMERS)	1990
1320-18-9	2,4-D ESTERS	1992
1321-12-6	NITROTOLUENE	1992
1327-52-2	ARSENIC ACID	1992
1327-53-3	ARSENIC TRIOXIDE	1992
1327-53-3	ARSENOUS OXIDE	1992
1330-20-7	XYLENE (MIXED ISOMERS)	1990
1332-07-6	ZINC BORATE	1992
1332-21-4	ASBESTOS (FRIABLE)	1990
1333-83-1	SODIUM BIFLUORIDE	1992
1335-32-6	LEAD SUBACETATE	1992
1335-87-1	HEXACHLORONAPHTHALENE	1990
1336-21-6	AMMONIUM HYDROXIDE	1992
1336-36-3	PCBS	1990
1336-36-3	POLYCHLORINATED BIPHENYLS	1990
1338-23-4	METHYL ETHYL KETONE PEROXIDE	1992
1338-24-5	NAPHTHENIC ACID	1992
1341-49-7	AMMONIUM BIFLUORIDE	1992
1344-28-1	ALUMINUM OXIDE (FIBROUS FORMS)	1990
1464-53-5	2,2'-BIOXIRANE	1990
1464-53-5	DIEPOXYBUTANE	1990
1563-66-2	CARBOFURAN	1992
1582-09-8	TRIFLURALIN	1990
1615-80-1	HYDRAZINE, 1,2-DIETHYL-	1992
1634-04-4	METHYL TERT-BUTYL ETHER	1990
1746-01-6	2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN (TCDD)	1992
1762-95-4	AMMONIUM THIOCYANATE	1992
1836-75-5	NITROFEN	1990
1863-63-4	AMMONIUM BENZOATE	1992
1888-71-7	HEXACHLOROPROPENE	1992
1897-45-6	CHLOROTHALONIL	1990
1918-00-9	DICAMBA	1992
1928-38-7	2,4-D ESTERS	1992
1928-47-8	2,4,5-T ESTERS	1992
1928-61-6	2,4-D ESTERS	1992
1929-73-3	2,4-D ESTERS	1992
1937-37-7	C.I. DIRECT BLACK 38	1990
2008-46-0	2,4,5-T AMINES	1992
2032-65-7	MERCAPTODIMETHUR	1992
2032-65-7	METHIOCARB	1992

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2164-17-2	FLUOMETURON	1990
2234-13-1	OCTACHLORONAPHTHALENE	1990
2303-16-4	DIALLATE	1990
2312-35-8	PROPARGITE	1992
2545-59-7	2,4,5-T ESTERS	1992
2602-46-2	C.I. DIRECT BLUE 6	1990
2763-96-4	5-(AMINOMETHYL)-3-ISOXAZOLOL	1992
2763-96-4	MUSCIMOL	1992
2764-72-9	DIQUAT	1992
2832-40-8	C.I. DISPERSE YELLOW 3	1990
2921-88-2	CHLORPYRIFOS	1992
2944-67-4	FERRIC AMMONIUM OXALATE	1992
2971-38-2	2,4-D ESTERS	1992
3012-65-5	AMMONIUM CITRATE, DIBASIC	1992
3118-97-6	C.I. SOLVENT ORANGE 7	1990
3164-29-2	AMMONIUM TARTRATE	1992
3165-93-3	4-CHLORO-O-TOLUIDINE, HYDROCHLORIDE	1992
3251-23-8	CUPRIC NITRATE	1992
3288-58-2	O,O-DIETHYL S-METHYL DITHIOPHOSPHATE	1992
3486-35-9	ZINC CARBONATE	1992
3689-24-5	SULFOTEP	1992
3689-24-5	TETRAETHYLDITHIOPYROPHOSPHATE	1992
3761-53-3	C.I. FOOD RED 5	1990
3813-14-7	2,4,5-T AMINES	1992
4170-30-3	CROTONALDEHYDE	1992
4549-40-0	N-NITROSOMETHYLVINYLAMINE	1990
4680-78-8	C.I. ACID GREEN 3	1990
5344-82-1	THIOUREA, (2-CHLOROPHENYL)-	1992
5893-66-3	CUPRIC OXALATE	1992
5972-73-6	AMMONIUM OXALATE	1992
6009-70-7	AMMONIUM OXALATE	1992
6369-96-6	2,4,5-T AMINES	1992
6369-97-7	2,4,5-T AMINES	1992
6484-52-2	AMMONIUM NITRATE (SOLUTION)	1990
6533-73-9	THALLIUM(I) CARBONATE	1992
6533-73-9	THALLOUS CARBONATE	1992
7005-72-3	4-CHLOROPHENYL PHENYL ETHER	1992
7421-93-4	ENDRIN ALDEHYDE	1992
7428-48-0	LEAD STEARATE	1992
7429-90-5	ALUMINUM (FUME OR DUST)	1990
7439-92-1	LEAD	1990
7439-96-5	MANGANESE	1990
7439-97-6	MERCURY	1990
7440-02-0	NICKEL	1990
7440-22-4	SILVER	1990
7440-23-5	SODIUM	1992
7440-28-0	THALLIUM	1990
7440-36-0	ANTIMONY	1990
7440-38-2	ARSENIC	1990
7440-39-3	BARIUM	1990
7440-41-7	BERYLLIUM	1990
7440-43-9	CADMIUM	1990
7440-47-3	CHROMIUM	1990
7440-48-4	COBALT	1990
7440-50-8	COPPER	1990
7440-62-2	VANADIUM (FUME OR DUST)	1990
7440-66-6	ZINC	1992
7440-66-6	ZINC (FUME OR DUST)	1990
7446-08-4	SELENIUM DIOXIDE	1992
7446-14-2	LEAD SULFATE	1992
7446-18-6	THALLIUM(I) SULFATE	1992
7446-18-6	THALLOUS SULFATE	1992
7446-27-7	LEAD PHOSPHATE	1992
7447-39-4	CUPRIC CHLORIDE	1992
7488-56-4	SELENIUM SULFIDE	1992
7550-45-0	TITANIUM TETRACHLORIDE	1990
7558-79-4	SODIUM PHOSPHATE, DIBASIC	1992
7601-54-9	SODIUM PHOSPHATE, TRIBASIC	1993
7631-89-2	SODIUM ARSENATE	1993
7631-90-5	SODIUM BISULFITE	1993
7632-00-0	SODIUM NITRITE	1993
7645-25-2	LEAD ARSENATE	1993
7646-85-7	ZINC CHLORIDE	1993
7647-01-0	HYDROCHLORIC ACID	1990
7647-01-0	HYDROGEN CHLORIDE (GAS ONLY)	1990
7647-18-9	ANTIMONY PENTACHLORIDE	1993
7664-38-2	PHOSPHORIC ACID	1990
7664-39-3	HYDROFLUORIC ACID	1990
7664-39-3	HYDROGEN FLUORIDE	1990
7664-41-7	AMMONIA	1990
7664-93-9	SULFURIC ACID	1990
7681-49-4	SODIUM FLUORIDE	1993
7681-52-9	SODIUM HYPOCHLORITE	1993
7697-37-2	NITRIC ACID	1990
7699-45-8	ZINC BROMIDE	1993
7705-08-0	FERRIC CHLORIDE	1993
7718-54-9	NICKEL CHLORIDE	1993
7719-12-2	PHOSPHORUS TRICHLORIDE	1993
7720-78-7	FERROUS SULFATE	1993
7722-64-7	POTASSIUM PERMANGANATE	1993
7723-14-0	PHOSPHORUS	1993
7723-14-0	PHOSPHORUS (YELLOW OR WHITE)	1990
7733-02-0	ZINC SULFATE	1993
7738-94-5	CHROMIC ACID	1993
7758-29-4	SODIUM PHOSPHATE, TRIBASIC	1993
7758-94-3	FERROUS CHLORIDE	1993
7758-95-4	LEAD CHLORIDE	1993
7758-98-7	CUPRIC SULFATE	1993

CAS#	Name	Year added to TURA List
7761-88-8	SILVER NITRATE	1993
7773-06-0	AMMONIUM SULFAMATE	1993
7775-11-3	SODIUM CHROMATE	1993
7778-39-4	ARSENIC ACID	1993
7778-44-1	CALCIUM ARSENATE	1993
7778-50-9	POTASSIUM BICHROMATE	1993
7778-54-3	CALCIUM HYPOCHLORITE	1993
7779-86-4	ZINC HYDROSULFITE	1993
7779-88-6	ZINC NITRATE	1993
7782-41-4	FLUORINE	1993
7782-49-2	SELENIUM	1990
7782-50-5	CHLORINE	1990
7782-63-0	FERROUS SULFATE	1993
7782-82-3	SODIUM SELENITE	1993
7782-86-7	MERCUROUS NITRATE	1993
7783-00-8	SELENIOUS ACID	1993
7783-06-4	HYDROGEN SULFIDE	1993
7783-20-2	AMMONIUM SULFATE (SOLUTION)	1990
7783-35-9	MERCURIC SULFATE	1993
7783-46-2	LEAD FLUORIDE	1993
7783-49-5	ZINC FLUORIDE	1993
7783-50-8	FERRIC FLUORIDE	1993
7783-56-4	ANTIMONY TRIFLUORIDE	1993
7784-34-1	ARSENOUS TRICHLORIDE	1993
7784-40-9	LEAD ARSENATE	1993
7784-41-0	POTASSIUM ARSENATE	1993
7784-46-5	SODIUM ARSENITE	1993
7785-84-4	SODIUM PHOSPHATE, TRIBASIC	1993
7786-34-7	MEVINPHOS	1993
7786-81-4	NICKEL SULFATE	1993
7787-47-5	BERYLLIUM CHLORIDE	1993
7787-49-7	BERYLLIUM FLUORIDE	1993
7787-55-5	BERYLLIUM NITRATE	1993
7788-98-9	AMMONIUM CHROMATE	1993
7789-00-6	POTASSIUM CHROMATE	1993
7789-06-2	STRONTIUM CHROMATE	1993
7789-09-5	AMMONIUM BICHROMATE	1993
7789-42-6	CADMIUM BROMIDE	1993
7789-43-7	COBALTOUS BROMIDE	1993
7789-61-9	ANTIMONY TRIBROMIDE	1993
7790-94-5	CHLOROSULFONIC ACID	1993
7791-12-0	THALLIUM CHLORIDE TLCL	1993
7791-12-0	THALLOUS CHLORIDE	1993
7803-51-2	PHOSPHINE	1993
7803-55-6	AMMONIUM VANADATE	1993
8001-35-2	CAMPHECHLOR	1990
8001-35-2	CAMPHENE, OCTACHLORO-	1990
8001-35-2	TOXAPHENE	1990
8001-58-9	CREOSOTE	1990
8003-19-8	DICHLOROPROPANE - DICHLOROPROPENE (MIXTURE)	1993
8003-34-7	PYRETHRINS	1993
8014-95-7	SULFURIC ACID (FUMING)	1993
10022-70-5	SODIUM HYPOCHLORITE	1993
10025-87-3	PHOSPHORUS OXYCHLORIDE	1993
10025-91-9	ANTIMONY TRICHLORIDE	1993
10026-11-6	ZIRCONIUM TETRACHLORIDE	1993
10028-22-5	FERRIC SULFATE	1993
10031-59-1	THALLIUM SULFATE	1993
10034-93-2	HYDRAZINE SULFATE	1990
10039-32-4	SODIUM PHOSPHATE, DIBASIC	1993
10043-01-3	ALUMINUM SULFATE	1993
10045-89-3	FERROUS AMMONIUM SULFATE	1993
10045-94-0	MERCURIC NITRATE	1993
10049-04-4	CHLORINE DIOXIDE	1990
10049-05-5	CHROMOUS CHLORIDE	1993
10099-74-8	LEAD NITRATE	1993
10101-53-8	CHROMIC SULFATE	1993
10101-63-0	LEAD IODIDE	1993
10101-89-0	SODIUM PHOSPHATE, TRIBASIC	1993
10102-06-4	URANYL NITRATE	1993
10102-18-8	SODIUM SELENITE	1993
10102-43-9	NITRIC OXIDE	1993
10102-44-0	NITROGEN DIOXIDE	1993
10102-45-1	THALLIUM(I) NITRATE	1993
10102-48-4	LEAD ARSENATE	1993
10108-64-2	CADMIUM CHLORIDE	1993
10124-50-2	POTASSIUM ARSENITE	1993
10124-56-8	SODIUM PHOSPHATE, TRIBASIC	1993
10140-65-5	SODIUM PHOSPHATE, DIBASIC	1993
10192-30-0	AMMONIUM BISULFITE	1993
10196-04-0	AMMONIUM SULFITE	1993
10361-89-4	SODIUM PHOSPHATE, TRIBASIC	1993
10380-29-7	CUPRIC SULFATE, AMMONIATED	1993
10415-75-5	MERCUROUS NITRATE	1993
10421-48-4	FERRIC NITRATE	1993
10544-72-6	NITROGEN DIOXIDE	1993
10588-01-9	SODIUM BICHROMATE	1993
11096-82-5	AROCLOR 1260	1993
11097-69-1	AROCLOR 1254	1993
11104-28-2	AROCLOR 1221	1993
11115-74-5	CHROMIC ACID	1993

List: TURA-3B
Mass. Toxics Use Reduction Act
for 1993 and beyond

CAS#	Name	Year added to TURA List
11141-16-5	AROCLOR 1232	1993
12002-03-8	CUPRIC ACETOARSENITE	1993
12002-03-8	PARIS GREEN	1993
12039-52-0	SELENIOUS ACIO, OITHALLIUM(1+) SALT	1993
12054-48-7	NICKEL HYDROXIOE	1993
12122-67-7	ZINEB	1990
12125-01-8	AMMONIUM FLUORIOE	1993
12125-02-9	AMMONIUM CHLORIOE	1993
12135-76-1	AMMONIUM SULFIDE	1993
12427-38-2	MANEB	1990
12672-29-6	AROCLOR 1248	1993
12674-11-2	AROCLOR 1016	1993
12771-08-3	SULFUR MONOCHLORIOE	1993
13463-39-3	NICKEL CARBONYL	1993
13560-99-1	2,4,5-T SALTS	1993
13597-99-4	BERYLLIUM NITRATE	1993
13746-89-9	ZIRCONIUM NITRATE	1993
13765-19-0	CALCIUM CHROMATE	1993
13814-96-5	LEAO FLUOBORATE	1993
13826-83-0	AMMONIUM FLUOBORATE	1993
13952-84-6	SEC-BUTYLAMINE	1993
14017-41-5	COBALTOUS SULFAMATE	1993
14216-75-2	NICKEL NITRATE	1993
14258-49-2	AMMONIUM OXALATE	1993
14307-35-8	LITHIUM CHROMATE	1993
14307-43-8	AMMONIUM TARTRATE	1993
14639-97-5	ZINC AMMONIUM CHLORIOE	1993
14639-98-6	ZINC AMMONIUM CHLORIOE	1993
14644-61-2	ZIRCONIUM SULFATE	1993
15699-18-0	NICKEL AMMONIUM SULFATE	1993
15739-80-7	LEAO SULFATE	1993
15950-66-0	2,3,4-TRICHLOROPHENOL	1993
16071-86-6	C.I. OIRECT BROWN 95	1990
16543-55-8	N-NITROSONORNICOTINE	1990
16721-80-5	SODIUM HYDROSULFIDE	1993
16752-77-5	ETHANIMIOOTHIOIC ACID, N-[[METHYLAMINO)CARBONYL]	1993
16752-77-5	METHOMYL	1993
16871-71-9	ZINC SILICOFLUORIDE	1993
16919-19-0	AMMONIUM SILICOFLUORIDE	1993
16923-95-8	ZIRCONIUM POTASSIUM FLUORIDE	1993
18883-66-4	D-GLUCOSE, 2-DEOXY-2-[[(METHYLNITROSOAMINO)-CARBONYL] AMINO]-	1993
20816-12-0	OSMIUM OXIDE OSO4 (T-4)-	1990
20816-12-0	OSMIUM TETROXIDE	1990
20830-81-3	DAUNOMYCIN	1993
20859-73-8	ALUMINUM PHOSPHIDE	1993
23950-58-5	BENZAMIOE, 3,5-DICHLORO-N-(1, 1-DIMETHYL-2-PROPYNYL)-	1993
25154-54-5	OINITROBENZENE (MIXED ISOMERS)	1993
25154-55-6	NITROPHENOL (MIXEO ISOMERS)	1993
25155-30-0	SODIUM OODECYLBENZENESULFONATE	1993
25167-82-2	TRICHLOROPHENOL	1993
25168-15-4	2,4,5-T ESTERS	1993
25168-26-7	2,4-D ESTERS	1993
25321-14-6	DINITROTOLUENE (MIXEO ISOMERS)	1990
25321-22-6	OICHLOROBENZENE	1990
25321-22-6	OICHLOROBENZENE (MIXED ISOMERS)	1990
25376-45-8	OIAMINOTOLUENE (MIXED ISOMERS)	1990
25376-45-8	TOLUENEDIAMINE	1990
25550-58-7	OINITROPHENOL	1993
26264-06-2	CALCIUM OOOECYLBENZENESULFONATE	1993
26471-62-5	TOLUENEOIISOCYANATE (MIXEO ISOMERS)	1990
26628-22-8	SODIUM AZIOE (NA(N3))	1993
26638-19-7	OICHLOROPROPANE	1993
27176-87-0	OOOECYLBENZENESULFONIC ACID	1993
27323-41-7	TRIETHANOLAMINE OOOECYLBENZENE SULFONATE	1993
27774-13-6	VANADYL SULFATE	1993
28300-74-5	ANTIMONY POTASSIUM TARTRATE	1993
30525-89-4	PARAFORMALDEHYDE	1993
32534-95-5	2,4,5-TP ESTERS	1993
33213-65-9	BETA-ENDOSULFAN	1993
36478-76-9	URANYL NITRATE	1993
37211-05-5	NICKEL CHLORIOE	1993
39156-41-7	2,4-DIAMINOANISOLE SULFATE	1990
39196-18-4	THIOFANOX	1993
42504-46-1	ISOPROPANOLAMINE OODECYLBENZENE SULFONATE	1993
52628-25-8	ZINC AMMONIUM CHLORIDE	1993
52652-59-2	LEAD STEARATE	1993
52740-16-6	CALCIUM ARSENITE	1993
53467-11-1	2,4-D ESTERS	1993
53469-21-9	AROCLOR 1242	1993
55488-87-4	FERRIC AMMONIUM OXALATE	1993
56189-09-4	LEAD STEARATE	1993
61792-07-2	2,4,5-T ESTERS	1993

This section contains a list of all the SIC codes that were reported for production units or facilities. The SIC codes are grouped into "User Segment" groups. This is a draft experimental grouping of 2-, 3-, and 4-digit SIC codes prepared by the TURA User Segment Advisory Subcommittee. (see Chapter 7) It should be noted that this list of groupings is an early draft and has not undergone any review.

SIC Group: 17 Special Trade Contractors

1761	Roofing, Siding, And Sheet Metal Work

SIC Group: 20 Food & Kindred Products

2023	Condensed and evaporated milk
2024	Ice cream and frozen desserts
2026	Fluid milk
2033	Canned fruits and vegetables
2035	Pickles, sauces, and salad dressings
2037	Frozen fruits, fruit juices and vegetables
2038	Frozen specialties
2051	Bread cake, and related products
2066	Chocolate and cocoa products
2077	Animal and marine fats and oils
2086	Bottled and canned soft drinks
2087	Flavoring extracts and syrups
2091	Canned and cured fish and seafoods
2092	Fresh or frozen prepared fish
2098	Macaroni and spaghetti
2099	Food preparations

SIC Group: 22 Misc. Textile Mill Products

2211	Broadwoven fabric mills, cotton
2221	Broadwoven fabric mills, man-made
2231	Broadwoven fabric mills, wool
2259	Knitting mills
2284	Thread mills
2295	Coated fabrics, not rubberized
2297	Nonwoven fabrics
2298	Cordage and twine
2299	Textile goods

SIC Group: 226 Dyeing & Finishing Textiles

2261	Finishing plants, cotton
2262	Finishing plants, man-made
2269	Finishing plants

SIC Group: 23 Apparel & Other Finished Textile Prod.

2353	Hats, caps, and millinery
2399	Fabricated textile products

SIC Group: 24 Lumber&Wood Prod. Except Furniture

2434 Wood kitchen cabinets
2491 Wood preserving
2499 Wood products

SIC Group: 25 Furniture & Fixtures

2511 Wood household furniture
2515 Mattresses and bedsprings
2519 Household furniture
2521 Wood office furniture
2522 Office furniture, except wood
2531 Public building and related furniture
2599 Furniture and fixtures

SIC Group: 26 Misc. Paper & Allied Products

2631 Paperboard mills
2652 Set-up paperboard boxes
2653 Corrugated and solid fiber boxes
2655 Fiber cans, drums, and similar products
2656 Sanitary Food Containers
2657 Folding paperboard boxes

SIC Group: 262 Paper Mills

2621 Paper mills

SIC Group: 267 Converted Paper/Paperboard Products

2671 Packaging paper and plastics film
2672 Coated and laminated paper
2674 Uncoated paper and multiwall bags
2676 Sanitary paper products
2677 Envelopes
2679 Converted paper and paperboard products

SIC Group: 27 Other Misc. Printing/Publishing/Allied

SIC Group: 273 Misc. Printing [273, 274, 275]

2732 Book printing
2741 Miscellaneous publishing
2752 Commercial printing, lithographic
2754 Commercial printing, gravure
2759 Commercial printing

SIC Group: 278 Blankbooks/Looseleaf Binders&Devices

2782 Blankbooks and looseleaf binders

SIC Group: 279 Platemaking & Related Services

2796 Platemaking services

SIC Group: 28 Other Chemicals & Allied Products

SIC Group: 281 Industrial Inorganic Chemicals

2812 Alkalies and chlorine
2813 Industrial gases
2819 Industrial inorganic chemicals

SIC Group: 282 Plastics Materials & Synthetic Rubber

2821 Plastics materials and resins
2822 Synthetic rubber
2824 Organic fibers, noncellulosic

SIC Group: 283 Drugs

2833 Medicinals and botanicals
2834 Pharmaceutical preparations
2835 Diagnostic substances

SIC Group: 284 Soaps/Detergents/Perfumes&Cosmetics

2841 Soap and other detergents
2842 Polishes and sanitation goods
2843 Surface active agents
2844 Toilet preparations

SIC Group: 285 Paints, Varnishes & Lacquers

2851 Paints and allied products

SIC Group: 286 Industrial Organic Chemicals

2865 Cyclic crudes and intermediates
2869 Industrial organic chemicals

SIC Group: 287 Agricultural Chemicals

SIC Group: 289 Misc. Chemical Products

SIC Group: 2891 Adhesives & Sealants

2891 Adhesives and sealants

SIC Group: 2893 Printing Inks

2893 Printing ink

SIC Group: 2899 Chemicals & Chem. Preparations, n.e.c.

2899 Chemical preparations

SIC Group: 29 Petrol. Refining&Related Industries

2992 Lubricating oils and greases
2999 Petroleum and coal products

SIC Group: 30 Misc.Rubber&Misc. Plastics Products

3021 Rubber and plastic footwear
3052 Rubber and plastic hose and belting
3053 Gaskets, packing and sealing devices

SIC Group: 306 Fabricated Rubber Products, n.e.c.

3061 Mechanical rubber goods
3069 Fabricated rubber products

SIC Group: 308 Plastics Products, n.e.c.

3081 Unsupported plastics film and sheet
3084 Plastics pipe
3086 Plastics foam products
3088 Plastics plumbing fixtures
3089 Plastics products

SIC Group: 31 Leather & Leather Products

3131 Footwear cut stock
3149 Footwear, except rubber
3199 Leather goods

SIC Group: 311 Leather Tanning & Finishing

3111 Leather tanning and finishing

SIC Group: 32 Stone, Clay, Glass&Concrete Products

3229 Pressed and blown glass and glassware
3264 Porcelain electrical supplies
3269 Pottery products
3275 Gypsum products
3291 Abrasive products
3295 Minerals, ground or treated

SIC Group: 33 Primary Metal

SIC Group: 331 Steel Works

3313 Electrometallurgical products
3316 Cold finishing of steel shapes

SIC Group: 3315 Steel Wiredrawing/Nails and Spikes

3315 Steel wire and related products

SIC Group: 332 Iron & Steel Foundaries

3321 Gray and ductile iron foundries
3324 Steel investment foundries
3325 Steel foundries

SIC Group: 333 Prim/2nd.Smelting/Refining [333, 334]

3331 Primary copper
3339 Primary nonferrous metals
3341 Secondary nonferrous metals

SIC Group: 335 Screw Machine Products,Bolts&Nuts

3351 Copper rolling and drawing
3354 Aluminum extruded products
3356 Nonferrous rolling and drawing
3357 Nonferrous wire drawing and insulating

SIC Group: 336 Nonferrous Foundaries

3363 Aluminum die-castings
3364 Nonferrous die-castings, except aluminum
3366 Copper foundries

SIC Group: 336 Nonferrous Foundaries

3369	Nonferrous foundries

SIC Group: 339 Misc. Primary Metal Products

3398	Metal heat treating
3399	Primary metal products

SIC Group: 34 Misc. Fabricated Metal Products

3411	Metal cans
3421	Cutlery
3423	Hand and edge tools
3425	Saw blades and handsaws
3429	Hardware
3433	Heating equipment, except electric
3441	Fabricated structural metal
3443	Fabricated plate work (boiler shops)
3444	Sheet metal work
3446	Architectural metal work
3451	Screw machine products
3452	Bolts, nuts, rivets and washers
3462	Iron and steel forgings
3469	Metal stampings
3484	Small arms
3489	Ordnance and accessories
3491	Metal valves
3494	Valves and pipe fittings
3495	Wire springs
3496	Miscellaneous fabricated wire products
3497	Metal foil and leaf
3498	Fabricated pipe and fittings
3499	Fabricated metal products

SIC Group: 347 Coatings, Engravings & Allied Services

3471	Plating and polishing
3479	Metal coating and allied services

SIC Group: 35 Indust/Comm. Machinery&Comp. Equip.

3511	Turbines and turbine generator sets
3541	Machine tools, metal cutting types
3544	Special dies, tools, jigs and fixtures
3545	Machine tool accessories
3554	Paper industries machinery
3555	Printing trades machinery
3556	Food products machinery
3559	Special industry machinery
3561	Pumps and pumping equipment
3566	Speed changers, drives, and gears

SIC Group: 35 Indust/Comm. Machinery&Comp. Equip.

3568	Power transmission equipment
3569	General industrial machinery
3571	Electronic computers
3572	Computer storage devices
3579	Office machines
3589	Service industry machinery
3599	Industrial machinery

SIC Group: 36 Electronic & Other Electrical Equipment

3612	Transformers, except electronic
3621	Motor and generators
3641	Electric lamps
3643	Current-carrying wiring devices
3644	Noncurrent-carrying wiring devices
3645	Residential lighting fixtures
3646	Commercial lighting fixtures
3661	Telephone and telegraph apparatus
3663	Radio and television communications equipment
3669	Communications equipment
3671	Electron tubes
3675	Electronic capacitors
3677	Electronic coils and transformers
3678	Electronic connectors
3679	Electronic components
3692	Primary batteries, dry and wet
3695	Magnetic and optical recording media
3699	Electrical equipment and supplies

SIC Group: 3672 Printed Circuit Boards

3672	Printed circuit boards

SIC Group: 3674 Semiconductors & Related Devices

3674	Semiconductors and related devices

SIC Group: 37 Transportation Equipment

3714	Motor vehicle parts and accessories
3724	Aircraft engines and engine parts
3728	Aircraft parts and equipment
3732	Boat building and repairing
3761	Guided missiles and space vehicles
3769	Space vehicle parts and equipment
3795	Tanks and tank components

SIC Group: 38 Measuring/Analyzing/Control Instrumnt

3812	Search and navigational equipment
3821	Laboratory Apparatus and Furniture
3822	Environmental controls
3823	Process control instruments
3825	Instruments to measure electricity
3826	Analytical instruments
3827	Optical instruments and lenses
3829	Measuring and controlling devices
3841	Surgical and medical instruments
3842	Surgical appliances and supplies
3845	Electromedical equipment
3851	Ophthalmic goods
3873	Watches, clocks, watchcases, and parts

SIC Group: 3861 Photographic Equipment & Supplies

3861	Photographic equipment and supplies

SIC Group: 39 Misc. Manufacturing

3952	Lead pencils, art goods
3991	Brooms and brushes
3993	Signs and advertising displays
3995	Burial caskets
3999	Manufacturing industries

SIC Group: 391 Jewelry, Silverware & Plated Ware

3911	Jewelry, precious metal
3914	Silverware and plated ware
3915	Jewelers' materials and lapidary work

SIC Group: 393 Musical Instruments

3931	Musical instruments

SIC Group: 394 Dolls/Toys/Games/Sport/&Athltc Goods

3944	Games, toys and children's vehicles
3949	Sporting and athletic goods

SIC Group: 396 Costume Jewel/Novelties/not PrecsMetals

3961	Costume jewelry
3965	Fasteners, buttons, needles, and pins

SIC Group: 45 Transportation by Air

4512 Air transportation, scheduled

SIC Group: 47 Transportation Services

4789 Transportation Services

SIC Group: 49 Electrical, Gas & Sanitary Services

4925 Gas production and/or distribution
4931 Electric and other services combined
4939 Combination utilities
4941 Water supply
4952 Sewerage systems
4953 Refuse systems
4959 Sanitary services
4961 Steam and air conditioning supply

SIC Group: 491 Electrical Services

4911 Electric services

SIC Group: 50 Wholesale Trade - Durable Goods

SIC Group: 51 Wholesale Trade - Nondurable Goods

5169 Chemicals and allied products
5172 Petroleum products

SIC Group: 72 Personal Services

7211 Power Laundries, Family & Commercial
7213 Linen supply
7216 Dry cleaning plants (except rug)
7218 Industrial launderers

SIC Group: 73 Business Services

7389 Business services

SIC Group: 75 Automotive Repair Services & Parking

7549 Automotive Services

SIC Group: 76 Repair Services

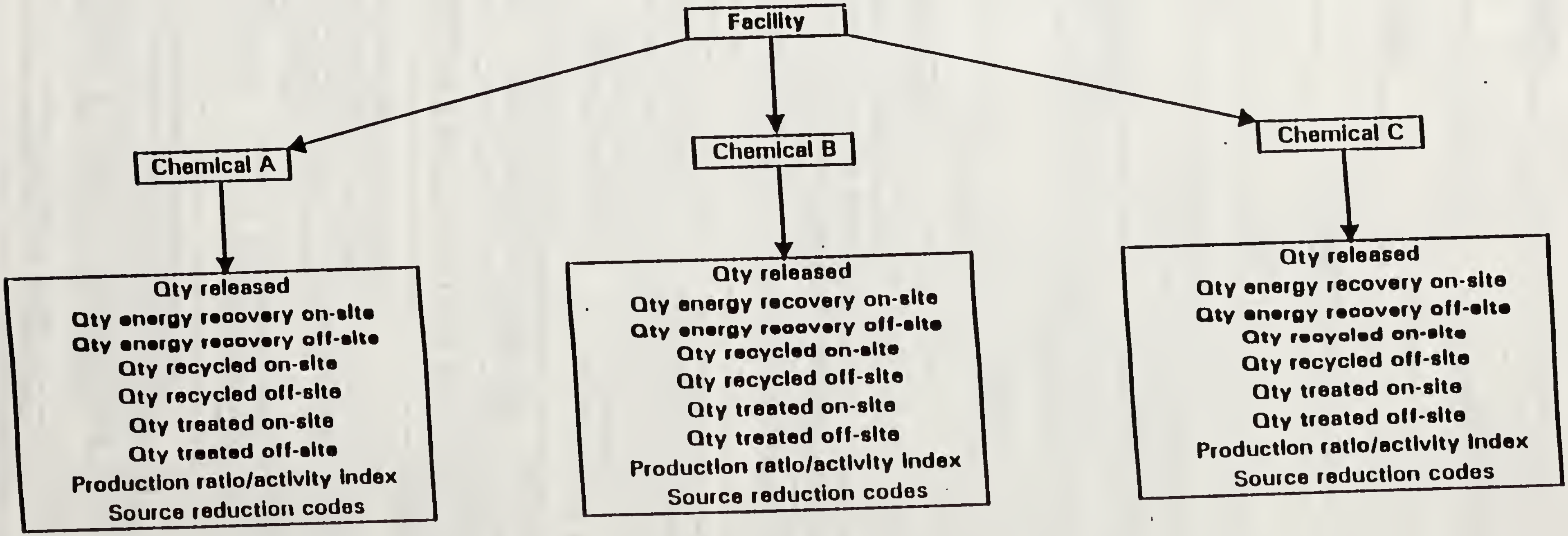
7699 Repair services

SIC Group: 80 Health Services

8099 Health and allied services

SIC Group: X Unclassified

Figure D1-1. TRI Form R Data



Source: Tellus Institute, "Taking Stock: Measuring Toxics Use Reduction Progress in Massachusetts", March 1995

(IMPORTANT: ..pe or print; read instructions before completing form)

Form Approved OMB Number: 2070-0093
Approval Expires: 11/92

EPA United States Environmental Protection Agency

FORM R TOXIC CHEMICAL RELEASE INVENTORY REPORTING FORM

Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986, also known as Title III of the Superfund Amendments and Reauthorization Act

TRI FACILITY ID NUMBER

Toxic Chemical, Category, or Generic Name

WHERE TO SEND COMPLETED FORMS:

1. EPCRA Reporting Center
P.O. Box 3348
Merrifield, VA 22116-3348
ATTN: TOXIC CHEMICAL RELEASE INVENTORY

2. APPROPRIATE STATE OFFICE
(See instructions in Appendix F)

Enter "X" here if this is a revision

For EPA use only

IMPORTANT: See instructions to determine when "Not Applicable (NA)" boxes should be checked.

PART I. FACILITY IDENTIFICATION INFORMATION

SECTION 1. REPORTING YEAR

19 ____

SECTION 2. TRADE SECRET INFORMATION

2.1 Are you claiming the toxic chemical identified on page 3 trade secret?

☐ Yes (Answer question 2.2; Attach substantiation forms)
☐ No (Do not answer 2.2; Go to Section 3)

2.2 If yes in 2.1, is this copy: ☐ Sanitized ☐ Unsanitized

SECTION 3. CERTIFICATION (Important: Read and sign after completing all form sections.)

I hereby certify that I have reviewed the attached documents and that, to the best of my knowledge and belief, the submitted information is true and complete and that the amounts and values in this report are accurate based on reasonable estimates using data available to the preparers of this report.

Name and official title of owner/operator or senior management official

Signature

Date Signed

SECTION 4. FACILITY IDENTIFICATION

4.1

Facility or Establishment Name

TRI Facility ID Number

Street Address

City

County

State

Zip Code

Mailing Address (if different from street address)

City

State

Zip Code

PUT LABEL HERE

EPA Form 9350-1 (Rev. 12/4/93) - Previous editions are obsolete.

United States Environmental Protection Agency

EPA FORM R

PART I. FACILITY IDENTIFICATION INFORMATION (CONTINUED)

TRI FACILITY ID NUMBER
Toxic Chemical, Category, or Generic Name

SECTION 4. FACILITY IDENTIFICATION (Continued)

4.2	This report contains information for: (Important: check only one)	a. ☐ An entire facility		b. ☐ Part of a facility		
4.3	Technical Contact	Name			Telephone Number (include area code)	
4.4	Public Contact	Name			Telephone Number (include area code)	
4.5	SIC Code (4-digit)	a.	b.	c.	d.	e.	f.

		Latitude			Longitude		
4.6	Latitude and Longitude	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds

4.7	Dun & Bradstreet Number(s) (9 digits)	a.
		b.
4.8	EPA Identification Number(s) (RCRA I.D. No.) (12 characters)	a.
		b.
4.9	Facility NPDES Permit Number(s) (9 characters)	a.
		b.
4.10	Underground Injection Well Code (UIC) I.D. Number(s) (12 digits)	a.
		b.

SECTION 5. PARENT COMPANY INFORMATION

5.1	Name of Parent Company	
	☐ NA	
5.2	Parent Company's Dun & Bradstreet Number	
	☐ NA	(9 digits)

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PART II. CHEMICAL-SPECIFIC INFORMATION

TRI FACILITY ID NUMBER
Toxic Chemical, Category, or Generic Name

SECTION 1. TOXIC CHEMICAL IDENTITY

(Important: DO NOT complete this section if you complete Section 2 below.)

1.1	CAS Number (Important: Enter only one number exactly as it appears on the Section 313 list. Enter category code if reporting a chemical category.)
1.2	Toxic Chemical or Chemical Category Name (Important: Enter only one name exactly as it appears on the Section 313 list.)
1.3	Generic Chemical Name (Important: Complete only if Part I, Section 2.1 is checked "yes." Generic Name must be structurally descriptive.)

SECTION 2. MIXTURE COMPONENT IDENTITY

(Important: DO NOT complete this section if you complete Section 1 above.)

2.1	Generic Chemical Name Provided by Supplier (Important: Maximum of 70 characters, including numbers, letters, spaces, and punctuation.)

SECTION 3. ACTIVITIES AND USES OF THE TOXIC CHEMICAL AT THE FACILITY

(Important: Check all that apply.)

3.1	**Manufacture the toxic chemical:**	a. ☐ Produce b. ☐ Import	If produce or import: c. ☐ For on-site use/processing d. ☐ For sale/distribution e. ☐ As a byproduct f. ☐ As an impurity
3.2	**Process the toxic chemical:**	a. ☐ As a reactant b. ☐ As a formulation component	c. ☐ As an article component d. ☐ Repackaging
3.3	**Otherwise use the toxic chemical:**	a. ☐ As a chemical processing aid b. ☐ As a manufacturing aid	c. ☐ Ancillary or other use

SECTION 4. MAXIMUM AMOUNT OF THE TOXIC CHEMICAL ON-SITE AT ANY TIME DURING THE CALENDAR YEAR

4.1	☐ (Enter two-digit code from instruction package.)

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PART II. CHEMICAL-SPECIFIC INFORMATION (CONTINUED)

TRI FACILITY ID NUMBER
Toxic Chemical, Category, or Generic Name

SECTION 5. RELEASES OF THE TOXIC CHEMICAL TO THE ENVIRONMENT ON-SITE

			A. Total Release (pounds/ year) (enter range code from instructions or estimate)	B. Basis of Estimate (enter code)	C. % From Stormwater
5.1	Fugitive or non-point air emissions	☐ NA			
5.2	Stack or point air emissions	☐ NA			
5.3	Discharges to receiving streams or water bodies (enter one name per box)				
5.3.1	Stream or Water Body Name				
5.3.2	Stream or Water Body Name				
5.3.3	Stream or Water Body Name				
5.4	Underground injections on-site	☐ NA			
5.5	Releases to land on-site				
5.5.1	Landfill	☐ NA			
5.5.2	Land treatment/ application farming	☐ NA			
5.5.3	Surface impoundment	☐ NA			
5.5.4	Other disposal	☐ NA			

☐ Check here only if additional Section 5.3 information is provided on page 5 of this form.

Range Codes: A = 1 - 10 pounds; B = 11 - 499 pounds; C = 500 - 999 pounds.

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PART II. CHEMICAL-SPECIFIC INFORMATION (CONTINUED)

TRI FACILITY ID NUMBER

Toxic Chemical, Category, or Generic Name

SECTION 5.3 ADDITIONAL INFORMATION ON RELEASES OF THE TOXIC CHEMICAL TO THE ENVIRONMENT ON-SITE

5.3 Discharges to receiving streams or water bodies (enter one name per box)	A. Total Release (pounds/year) (enter range code from instructions or estimate)	B. Basis of Estimate (enter code)	C. % From Stormwater
5.3.__ Stream or Water Body Name			
5.3.__ Stream or Water Body Name			
5.3.__ Stream or Water Body Name			

SECTION 6. TRANSFERS OF THE TOXIC CHEMICAL IN WASTES TO OFF-SITE LOCATIONS

6.1 DISCHARGES TO PUBLICLY OWNED TREATMENT WORKS (POTW)

6.1.A Total Quantity Transferred to POTWs and Basis of Estimate

6.1.A.1 Total Transfers (pounds/year) (enter range code or estimate)	6.1.A.2 Basis of Estimate (enter code)

6.1.B POTW Name and Location Information

6.1.B.__	6.1.B.__
POTW Name	POTW Name
Street Address	Street Address
City / County	City / County
State / Zip Code	State / Zip Code

If additional pages of Part II, Sections 5.3 and/or 6.1 are attached, Indicate the total number of pages in this box [ ] and indicate which Part II, Sections 5.3/6.1 page this is, here. [ ]
(example: 1, 2, 3, etc.)

Range Codes: A = 1 - 10 pounds; B = 11 - 499 pounds;
C = 500 - 999 pounds.

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TRI FACILITY ID NUMBER
Toxic Chemical, Category, or Generic Name

SECTION 6.2 TRANSFERS TO OTHER OFF-SITE LOCATIONS

6.2.__	Off-site EPA Identification Number (RCRA ID No.)		
Off-Site Location Name			
Street Address			
City		County	
State	Zip Code	Is location under control of reporting facility or parent company?	☐ Yes ☐ No

A. Total Transfers (pounds/year) (enter range code or estimate)	B. Basis of Estimate (enter code)	C. Type of Waste Treatment/Disposal/ Recycling/Energy Recovery (enter code)
1.	1.	1. M
2.	2.	2. M
3.	3.	3. M
4.	4.	4. M

SECTION 6.2 TRANSFERS TO OTHER OFF-SITE LOCATIONS

6.2.__	Off-site EPA Identification Number (RCRA ID No.)		
Off-Site Location Name			
Street Address			
City		County	
State	Zip Code	Is location under control of reporting facility or parent company?	☐ Yes ☐ No

A. Total Transfers (pounds/year) (enter range code or estimate)	B. Basis of Estimate (enter code)	C. Type of Waste Treatment/Disposal/ Recycling/Energy Recovery (enter code)
1.	1.	1. M
2.	2.	2. M
3.	3.	3. M
4.	4.	4. M

If additional pages of Part II, Section 6.2 are attached, indicate the total number of pages in this box ☐ and indicate which Part II, Section 6.2 page this is, here. ☐ (example: 1, 2, 3, etc.)

EPA Form 9350-1 (Rev. 12/4/93) - Previous editions are obsolete.

Range Codes: A = 1 - 10 pounds; B = 11 - 499 pounds; C = 500 - 999 pounds.

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PART II. CHEMICAL-SPECIFIC INFORMATION (CONTINUED)

TRI FACILITY ID NUMBER
Toxic Chemical, Category, or Generic Name

SECTION 7A. ON-SITE WASTE TREATMENT METHODS AND EFFICIENCY

☐ Not Applicable (NA) - Check here if no on-site waste treatment is applied to any waste stream containing the toxic chemical or chemical category.

a. General Waste Stream (enter code)	b. Waste Treatment Method(s) Sequence [enter 3-character code(s)]	c. Range of Influent Concentration	d. Waste Treatment Efficiency Estimate	e. Based on Operating Data?
7A.1a	7A.1b 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐	7A.1c	7A.1d %	7A.1e Yes ☐ No ☐
7A.2a	7A.2b 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐	7A.2c	7A.2d %	7A.2e Yes ☐ No ☐
7A.3a	7A.3b 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐	7A.3c	7A.3d %	7A.3e Yes ☐ No ☐
7A.4a	7A.4b 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐	7A.4c	7A.4d %	7A.4e Yes ☐ No ☐
7A.5a	7A.5b 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐	7A.5c	7A.5d %	7A.5e Yes ☐ No ☐

If additional copies of page 7 are attached, indicate the total number of pages in this box ☐ and indicate which page 7 this is, here. ☐ (example: 1, 2, 3, etc.)

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PART II. CHEMICAL-SPECIFIC INFORMATION (CONTINUED)

TRI FACILITY ID NUMBER

Toxic Chemical, Category, or Generic Name

SECTION 7B. ON-SITE ENERGY RECOVERY PROCESSES

☐ Not Applicable (NA) - Check here if no on-site energy recovery is applied to any waste stream containing the toxic chemical or chemical category.

Energy Recovery Methods [enter 3-character code(s)]

1 ☐ 2 ☐ 3 ☐ 4 ☐

SECTION 7C. ON-SITE RECYCLING PROCESSES

☐ Not Applicable (NA) - Check here if no on-site recycling is applied to any waste stream containing the toxic chemical or chemical category.

Recycling Methods [enter 3-character code(s)]

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

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PART II. CHEMICAL-SPECIFIC INFORMATION (CONTINUED)

TRI FACILITY ID NUMBER
Chemical, Category, or Generic Name

SECTION 8. SOURCE REDUCTION AND RECYCLING ACTIVITIES

All quantity estimates can be reported using up to two significant figures.		Column A 1992 (pounds/year)	Column B 1993 (pounds/year)	Column C 1994 (pounds/year)	Column D 1995 (pounds/year)
8.1	Quantity released *				
8.2	Quantity used for energy recovery on-site				
8.3	Quantity used for energy recovery off-site				
8.4	Quantity recycled on-site				
8.5	Quantity recycled off-site				
8.6	Quantity treated on-site				
8.7	Quantity treated off-site				

8.8	Quantity released to the environment as a result of remedial actions, catastrophic events, or one-time events not associated with production processes (pounds/year)	
8.9	Production ratio or activity index	

8.10 Did your facility engage in any source reduction activities for this chemical during the reporting year? If not, enter "NA" in Section 8.10.1 and answer Section 8.11.

	Source Reduction Activities [enter code(s)]	Methods to Identify Activity (enter codes)		
8.10.1		a.	b.	c.
8.10.2		a.	b.	c.
8.10.3		a.	b.	c.
8.10.4		a.	b.	c.

		YES	NO
8.11	Is additional optional information on source reduction, recycling, or pollution control activities included with this report? (Check one box)	☐	☐

* Report releases pursuant to EPCRA Section 329(8) including "any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment." Do not include any quantity treated on-site or off-site.

Example 14: Determining a Production Ratio

Your facility's only use of toluene is as a paint carrier for a painting operation. You painted 12,000 refrigerators in the current reporting year and 10,000 refrigerators during the preceding year. The production ratio for toluene in this case is 1.2 (12,000/10,000) because the number of refrigerators produced is the primary factor determining the quantity of toluene to be reported in Sections 8.1 through 8.7.

A facility manufactures inorganic pigments, including titanium dioxide. Hydrochloric acid is produced as a waste byproduct during the production process. An appropriate production ratio for hydrochloric acid is the annual titanium dioxide production, not the amount of byproduct generated. If the facility produced 20,000 pounds of titanium dioxide during the reporting year and 26,000 pounds in the preceding year, the production ratio would be 0.77 (20,000/ 26,000).

8.9 Production Ratio or Activity Index

For Section 8.9, you must provide a ratio of reporting year production to prior year production, or provide an "activity index" based on a variable other than production that is the primary influence on the quantity of the reported toxic chemical recycled, used for energy recovery, treated, or disposed. The ratio or index must be reported to the nearest tenths or hundredths place (e.g., one or two digits to the right of the decimal point). If the manufacture or use of the reported toxic chemical began during the current reporting year, enter not applicable, "NA," as the production ratio or activity index.

It is important to realize that if your facility reports more than one reported toxic chemical, the production ratio or activity index may vary for different chemicals. For facilities that manufacture reported toxic chemicals, the quantities of the toxic chemical(s) produced in the current and prior years provide a good basis for the ratio because that is the primary business activity associated with the reported toxic chemical(s). In most cases, the production ratio or activity index must be based on some variable of production or activity rather than on toxic chemical or material usage. Indices based on toxic chemical or material usage may reflect the effect of source reduction activities rather than changes in business activity. Toxic chemical or material usage is therefore not a basis to be used for the production ratio or activity index where the toxic chemical is "otherwise-used" (i.e., non-incorporative activities such as extraction solvents, metal degreasers, etc.).

While several methods are available to the facility for determining this data element, the production ratio or activity index must be based on the variable that most directly affects the quantities of the toxic chemical recycled, used for energy recovery, treated, or disposed. Examples of methods available include:

(1) Amount of toxic chemical manufactured in 1993 divided by the amount of toxic chemical manufactured in 1992; or

(2) Amount of product produced in 1993 divided by the amount of product produced in 1992.

EXECUTIVE SUMMARY

In February 1991, the Massachusetts Department of Environmental Protection (DEP) submitted a project proposal to the Civil Engineering Department at Tufts University. The objectives of the project were to 1) identify and evaluate the sources of information regarding industrial toxics use and waste generation within the Commonwealth, 2) identify and evaluate available measurement methodologies for tracking progress in toxics use and waste reduction, and 3) recommend a method or methods that DEP can use to meet its needs. The project was accepted by Tufts for inclusion in the 1991 Capstone Masters Degree Program.

In 1989, Massachusetts enacted the Toxics Use Reduction Act (TURA). Adoption of the Act reflected the shift in focus from environmental legislation that had primarily relied on "end-of-pipe " regulations to control toxics and manage wastes to an approach which reduces toxics at the source.

The goal of TURA is "to achieve, by 1997, a fifty percent (50%) reduction from the 1987 quantities of toxic and hazardous byproducts generated by industry in the commonwealth of Massachusetts" (MGL c. 21I, Toxics Use Reduction Act). Under the Act, DEP is charged with evaluating annual progress towards TURA's 50% reduction goal. To meet this responsibility, DEP requires a measurement methodology that can quantify toxic byproduct reductions on a state-wide level. As of yet, there is no single agreed upon method that will provide this information.

Data Evaluation

The paper provides a general evaluation of the utility of three data sets in measuring toxics use reduction on a state-wide basis. The general evaluation was based on a review of the reporting requirements associated with the following data sets:

- Monitoring Data
- Toxics Release Inventory (TRI) Data (under current and proposed programs)
- Toxics Use Report Data

The general evaluation involved the application of three criteria that pertain to; a) the data's a ailability in compiling a complete and consistent database, b) the data's applicability in measuring toxics use reduction, and c) the data's reliability in reflecting actual quantities.

The general evaluation resulted in the identification of the strengths and limitations relative to the utility of the data sets. The major limitation in using the monitoring data and current TRI data to measure toxics use reduction is associated with the applicability of the data. These data sets primarily include emissions, measured after treatment and recycling, rather than byproduct data, measured prior to treatment and recycling. Therefore, they have limited utility in measuring reduction in byproduct quantities.

A limitation identified in utilizing the TURA data to measure reductions stems from the need to adjust or "normalize" the data to account for changes in production rate. This limitation is addressed in this paper by recommending a methodology that can be used to obtain the normalized data. Other limitations identified for the TRI and TURA data sets are associated with the data's availability and reliability.

Facility-specific data were evaluated to support the conclusions of the general evaluations relative to the utility of the data sets. These data were compiled from DEP files on thirteen selected facilities. These facilities, which consist of metal intensive industries located in the central Massachusetts area, were selected because they had been previously studied by the DEP and were therefore well documented.

The evaluation of the facility-specific data, which includes TRI Form R and TURA Form S data, verifies the conclusions of the general evaluation of the data sets. The evaluation of the facility-specific data demonstrates a major limitation in the utility of the TRI data in measuring toxics use reduction. This limitation exists because the data reflect emission rather than byproduct quantities.

The facility-specific data evaluation also included telephone interviews with personnel of the selected facilities. Information obtained from the interviews provided insight into the methods and assumptions used in determining the reported data. The information indicated significant variation in the methods used by the facilities. This variation affects the reliability of the compiled data sets in reflecting actual quantities and consequently will affect the utility of the data in measuring toxics use reduction.

Measurement Methods

Available measurement methods were evaluated to determine their appropriateness in measuring progress in toxics use reduction. Evaluation criteria included information requirements, quantities to be measured, accuracy in reflecting toxics use reduction, versatility, and whether results could be meaningfully aggregated at the state-wide level.

The following general approaches to measuring progress were evaluated:

- Actual Quantity
- Production Normalized
- Throughput
- Economic
- Technological
- Degree of Hazard

The evaluation concluded that actual quantity and production normalized best satisfied the criteria for measuring progress in toxics use reduction under TURA. While degree of hazard is an important consideration in measuring progress, lack of an existing comprehensive classification system, as well as the information necessary in order to implement such a system, prohibits its use by DEP at this time.

Two approaches to measuring production normalized progress at the state-wide level were considered. The first utilizes normalized data reported at the production unit level, and aggregates that data to the state-wide level. The second approach aggregates actual quantities to the state-wide level, and then normalizes based on a state-wide indicator of production activity. Available public-sector data was evaluated to determine the best indicator of state-wide production activity.

Measuring State-Wide Progress

Application of measurement techniques to available data produced the following methods which provide the most accurate measure of state-wide progress:

Objective No. 1: Reduce total toxics use in the Commonwealth of Massachusetts

Recommended Method A: Sum facility-level actual byproduct quantities to state-wide total. Calculate percent reduction in total quantity of byproduct.

Objective No. 2: Reduce toxics use after adjustment for production activity

Recommended Method B: Sum actual quantities as in Method A. Normalize total using state-wide indicator of production activity. (Annually use employment data, or value-added manufacture for years 1992 and 1997)

Recommended Method C: Calculate a facility-wide, and then state-wide reductions using either actual quantity reduction or a weighted average of Byproduct Reduction Indices. Weighting to be based on the amount of byproduct that would have been produced in the measuring year, if no toxics use reduction had taken place.

Method C represents the most accurate representation of state-wide progress in toxics use reduction, however, it requires information which is not currently reported under TURA. It is recommended that the following additional information be required for each chemical on TURA Form S, in order to utilize method C:

- Facility-wide Byproduct Reduction Index
- Total Expected Quantity of Byproduct (quantity of byproduct that would have been produced in reporting year if no toxics use reduction had taken place since base year, based on production ratios)

The recommended methods do not represent calculation of absolute, accurate measurement of state-wide toxics use reduction. In aggregating normalized data, inaccuracies are introduced due to dissimilarities in chemicals, uses of chemicals, and units of product, as well as other confounding factors such as varying chemical and facility coverage over time.

The most meaningful results will be obtained by using multiple indicators of progress as outlined above. This will both address TURA's dual objectives, and incorporate techniques which handle inaccuracies and confounding factors differently. This will allow a *range* of toxics use reduction to be defined.

While the errors in data and methods will *distort* results, it is unlikely that they will *obscure* progress. A thorough testing of the recommended methods using actual data will be required in order to estimate the true error involved, and to determine if the methods produce results which are sufficiently accurate for DEP's purposes.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Utility and Quality of the Data

Section 4 presented a general evaluation of the utility of data sets in assessing the progress in toxics use reduction on a statewide basis. Assessment of progress is to be accomplished by tracking the reduction in the quantity of byproduct generated per unit of product. In accordance with the criteria applied in the general evaluation, the data set must represent a complete and consistent database and must reliably reflect the quantities of byproduct rather than emissions.

The general evaluation identified that the major limitation associated with the utility of monitoring data and current TRI data in measuring toxics use reduction is due to the fact that these data primarily reflect quantities of emissions. These quantities are determined following any treatment or recycling of the wastestream. Monitoring data and TRI data provided for untreated wastestreams do reflect byproduct quantities. These data could possibly be used to verify or supplement TURA data, but alone are not sufficient to assess overall progress. In addition, the diversity of the reporting requirements prevents the aggregation of monitoring data across various wastestreams. Such aggregation is necessary in compiling a complete and consistent database.

The amendments to Form R under the federal Pollution Prevention Act and the TURA Form S will generate data on the quantity of byproducts. Data from the amended Form R will be available in 1992. The major limitation associated with the utility of the TURA data in measuring toxics use reduction occurs because the facility-wide byproduct data are not normalized to account for variations in production rate; only production unit data are normalized. The amended Form R will provide facility level production normalized data. However, draft instructions do not require calculation of production activity at the production unit level, and, in fact, allow facilities enormous flexibility in choosing the basis for normalization. As the draft form and instructions stand, it is doubtful whether a meaningful measure of production activity will be obtained.

Another limitation identified for both the TRI and TURA data pertains to the reliability of the data. The reliability of these data is a function of their accuracy, which will vary significantly depending on the methods and assumptions used in determining the reported quantities. As documented in Section 5, the quality of TURA 1990 data is questionable.

To improve the accuracy of the data, federal and state regulators should develop guidelines for recommended measurement/estimation methods to be used for wastestreams associated with standard processes and categorical emissions. Facilities should also be assisted in establishing adequate systems for tracking materials as part of a materials accounting program. Such a program is essential to determining accurate byproduct quantities.

Both general and specific evaluations of TURA and TRI data unveiled important limitations regarding their utility in measuring progress:

- 1987 base year not possible
- facilities dropping below threshold
- chemical list and facility coverage issues

Further investigation is necessary in order to determine the magnitude of error which will be introduced by these limitations.

7.2 Measuring State-wide Progress

There is no single ideal method for measuring progress in toxics use reduction. The degree to which each method satisfies the criteria of accuracy, information requirements, versatility, and ability to be aggregated, depends on the level at which progress is measured, as well as the program objectives. The primary focus of this project was to determine a methodology with which to measure progress in the reduction of byproduct generation, via toxics use reduction, at the state-wide level.

Our recommendation for measuring progress at the state-wide level is to use multiple indicators of progress to address TURA's dual objectives, and to utilize all appropriate sources of information. Recommended Methods A and B utilize existing information available to DEP. Method C requires additional information as noted.

Objective No. 1: To reduce total toxics use in the Commonwealth of Massachusetts.

Recommended Method A: Actual Quantity

Aggregate total byproduct quantities, as provided at the facility level on TURA Form S, and compute a percent reduction in total quantity of byproduct.

Objective No. 2: To reduce toxics use after adjustment for changes in production activity.

Recommended Method B: Production Normalized at State level

Aggregate total byproduct quantities, as provided at the facility level on TURA Form S. Normalize using a state-wide indicator of production activity; then compute percent normalized reduction. Use the following as a proxy for state-wide production:

Annually: Manufacturing employment data, adjusted for changes in manufacturing productivity (measured at the national level, until results regarding state trends are obtained).

For years 1992, 1997: Value-added by manufacture

Recommended Method C: Production Normalized at Production Unit Level

Two alternate methods of calculation:

Actual Quantity Application:
Calculates the actual quantity of byproduct reduction, after adjustment for production activity, for individual production units, and then sums these totals to calculate facility-wide actual quantity and percentage byproduct reductions. State-wide reductions can then be calculated in a similar fashion using facility-wide totals.

Weighted Average Application:
Calculate a facility-wide weighted average of byproduct reduction indices (BRI's) for each chemical. Weighting to be based on the amount of byproduct that would have been produced in the measuring year, if no toxics use reduction had been implemented since the base year. A state-wide weighted average can then be calculated from facility BRI's in a similar fashion.

The first two methods, A and B, involve only the summing of total byproduct quantities from Form S and nominal calculations associated with state-wide production indicators. Production normalized results computed in this manner may have significant sources of error. For example:

- Employment patterns may not parallel production patterns
- National productivity trends may not parallel state trends
- Based on total quantity data, therefore facilities falling below threshold will be counted as having eliminated byproduct generation. If significant number of facilities fall below threshold due to toxics use reduction, result will be overstatement of state-wide progress.

Methods A and B are based on utilization of the information currently reported on TURA Form S. A production normalized method based on the individual BRI's (Method C), rather than on state-wide indicators, would result in a more accurate measure of progress; however, this requires information not currently reported.

BRI's are currently required on Form S at the production unit level, while total byproduct quantities are required for the facility as a whole. There is no means of determining what portion of the total can be attributed to each production unit. Because industry may regard quantity/production unit as confidential information, they have objected to reporting it.

Therefore, our recommendation is that facilities be required to calculate facility-wide production normalized reductions and to report these results on Form S. In addition, the facility-wide 'expected quantity' (assuming no source reduction) must be reported. This method does not involve collection of any additional data by facilities, only further manipulation of the quantities already used to calculate BRI's.

It should be noted that these methods do not represent calculation of an absolute, accurate measure of state-wide progress in toxics use reduction. In aggregating normalized data, inaccuracies are introduced due to the dissimilarities in chemicals, uses of chemicals, and units of product. In addition, there are a number of factors which will affect the result, and may obscure true toxics use reduction efforts. Each measurement method handles these confounding factors differently. For example, facilities falling below threshold will cause overstatement of progress in one method and understatement in another. In some cases, inconsistencies may cancel out.

While the majority of research literature has concluded that *meaningful* results cannot be obtained by aggregating normalized data, it would seem reasonable to identify the most meaningful methodologies, and then determine their adequacy.

As a result of this examination of the data and methods available, the most meaningful results will be obtained by utilizing multiple indicators of progress, as shown above. If the additional data can be obtained, the facility-wide production normalized Method C will likely provide the most meaningful indicator of progress. Utilizing multiple indicators will both address TURA's dual objectives, and incorporate techniques which handle confounding factors differently, thereby allowing a *range* of toxics use reduction progress to be defined.

While the errors in data and methods will certainly *distort* results, it is unlikely that they will *obscure* progress. A thorough testing of the recommended methods using actual data will be required in order to estimate the true error involved, and to determine if the methods produce results which are sufficiently accurate for DEP's purposes.

7.3 Further Study

As a result of this investigation, the following areas are recommended for further study:

- The effect of small quantity users on state-wide reduction. If patterns of toxics use reduction parallel those of large quantity users, there will be no error introduced by disregarding small quantity users.

- Effects due to the expanding chemical list and increased SIC code coverage. A determination must be made on how or whether to include these in measurement of progress. If they are to be included, methods for handling additional coverage with different base years must be developed. State-wide indicators for non-manufacturing SIC codes must be investigated.

- Changing productivity trends in Massachusetts. An analysis must be undertaken to determine whether changes in productivity trends in Massachusetts mirror those of the nation. If they do not, can they be reliably estimated?

- Research relevance of value-added by manufacture as a proxy for state-wide production activity.

- Sensitivity analysis of confounding factors and other sources of error in recommended methods.

- Effects due to facilities dropping below threshold as a result of toxics use reduction. Investigate feasibility and benefits of requiring all facilities which have ever filed a TURA Form S, to file in 1997.

- Pilot study of additional reporting requirements for recommended production normalized measurement method. An industry survey of a modified Form S would provide valuable information regarding the ability and willingness of industry to furnish additional data.

- Tests of recommended methods using actual data. This may be done after 1990 and 1991 data have been compiled (late 1992 or 1993).

EXECUTIVE SUMMARY

Five years ago the Massachusetts Legislature passed the Toxics Use Reduction Act (TURA), promoting toxics use reduction (TUR) as an effective pollution prevention method for improving worker and environmental health and safety. The Act set a goal of reducing toxic waste generation, by 50% by 1997, using TUR to meet this goal.

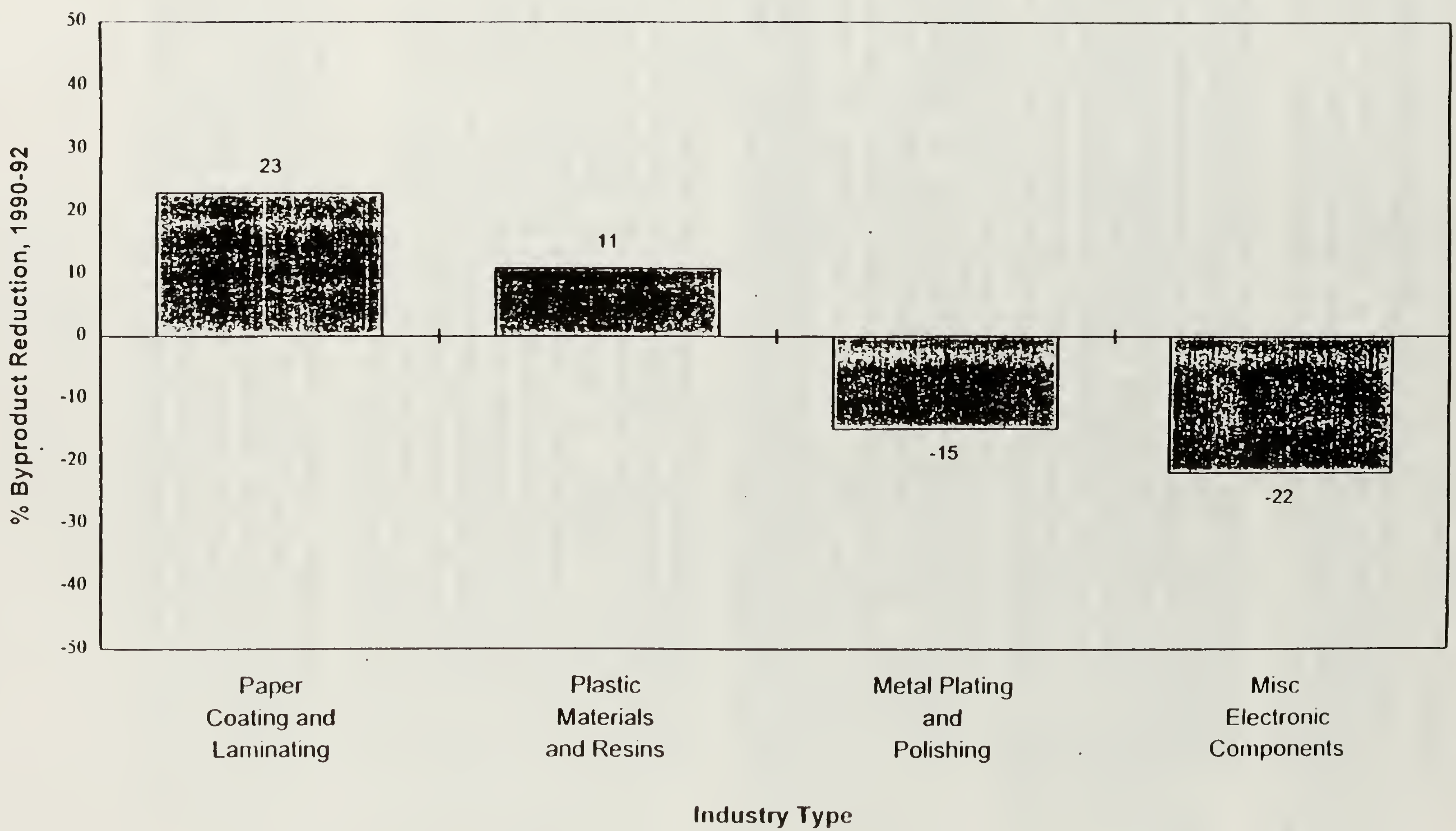
Five years after is passage, are Massachusetts industries making progress towards this goal? Measuring progress presents several challenges -- are qualitative or quantitative indicators preferable? While qualitative measures (e.g., percentage of facilities with P2 plans) generally require less detailed data than quantitative indicators, quantitative data can provide concrete and comparable evaluation of TUR trends (for example, changes in a facility's toxic byproducts from year to year). One of the greatest challenges in assessing TUR progress is how to distinguish progress due to explicit prevention efforts from other, unrelated factors such as changes in a company's product mix or changes in production levels.

Because methods for measuring TUR progress are in the nascent stage, this study develops and applies a methodology to five industry sectors (as identified by SIC codes). Tellus's methodology uses a combination of qualitative and quantitative measures from data filed annually by Massachusetts facilities (required under TURA) as well as data available from the Toxics Release Inventory (TRI). Qualitative data including TUR technique codes and source reduction activity codes (describing the types of TUR techniques and source reduction implemented at a facility) provide insight to the TUR activity level within a facility and an SIC group. However, quantitative data provide a more concrete evaluation of TUR progress.

Tellus' initial assessment of TUR progress by four industrial sectors suggests limited and mixed progress to date as shown in Figure ES-1. This figure shows the percent reduction in byproduct generation by facilities within each SIC code between the years 1990 and 1992 (1993 data are not yet available). A positive number indicates decreases in byproduct generation during this time period while a negative number indicates increases in byproduct generation. Facilities that coat and laminate paper (SIC 2672) and plastic materials and resins manufacturers (SIC 2821) have decreased their generation of toxic byproducts over the two year period. Metal plating and polishing operations (SIC 3471) increased byproducts by 15% and miscellaneous electronic component manufacturers (SIC 3679) increased byproducts by 22%. Due to probable data reporting errors, it is impossible to assess progress for miscellaneous plastic products manufacturers (SIC 3089).

This study examines normalized measures of TUR using the number of employees in an industry sector as an indicator of the sector's product output. *If* product output is correlated with chemical use and byproduct production, *then* changes in employment (as a proxy for output) may explain changes in chemical quantities. For example, if employment in an industry sector is declining, and chemical use is also declining, then a decline in business, rather than TUR, may be the root cause of declining chemical use. Conversely, if an industry

Figure ES-1. Byproduct Reductions in Five Massachusetts Industries (1990-1992)



sector is growing (as evidenced by increasing employment), but its chemical use is declining, TUR progress is suggested. Since only five industry categories were assessed in this study, further application of our normalization techniques are necessary before definitive conclusions are possible.

Since 1990 (the first year Massachusetts industries began filing TURA data), the number of SIC codes and chemicals reportable under TURA have expanded. This expanding list of reportable chemicals and facilities may potentially mask TUR progress. At the SIC code level, this study concludes that quantitative analyses should be limited to those chemicals reportable in 1990. For example, for SIC 2821, byproduct generation appears to **increase** by 9% between 1990 and 1992 when all reportable chemicals are considered. When the analysis is limited to 1990 reportable chemicals, byproducts **decrease** by an 11%. Once the list of reportable chemicals becomes constant, it will be possible to begin measuring progress with the larger list. Similarly, when measuring progress at the state level, it is important to hold the SIC codes and chemicals constant.

Our study relies on three years of TURA data and two years of TRI data. Assessing trends over such as short time period is naturally difficult -- short term fluctuations may conceal longer term trends visible only with more time-series data. Measuring progress is an ongoing activity that should be repeated yearly. As the database becomes more stable once all reportable chemicals are phased in, the methodology developed in this study will be increasingly useful for taking stock of TUR progress in Massachusetts.

Appendix F - EXAMPLES OF TURA DATA STRUCTURE ISSUES

1 Introduction

A number of problems with using the TURA data for measuring progress are due to the way the TURA legislation mandated that the data be collected and with some of the resulting reporting procedures. The legislation mandates the format in which the data be collected. The format includes collecting data at three different levels. Some information is collected at the chemical level, some is collected at the individual production unit level, and some is collected at the level of the specific chemical use in individual production units. (See Appendices A and D for samples of the forms used to collect the data.)

This Appendix describes how the data is structured and provides examples of what a facility's information might look like. The purpose of this Appendix is to describe in detail how the data is reported and stored in the FMF system. It also explains how the resulting data structure hinders measuring progress in TUR at the industry or state-wide level. The rest of this section describes the data structure. The following sections provide specific examples.

Chemical Level - At the chemical level, a facility reports the total amount of chemical used in the entire facility in three categories: manufactured, processed, and otherwise used. A facility also reports the total amount of byproduct generated and the amount shipped in or as product.

Production Unit Level - For each production unit in which any listed chemicals are used, the facility reports on the product made in the unit, the production process used to make the product, and the industry SIC codes that best describe the product. Facilities may report more than one SIC code but the first one listed is supposed to be the primary SIC code for the production unit.

Chemical-Production Unit Level - For every chemical and each production unit in which it is used, the facility reports a code for the amount of the chemical used in the production unit expressed as a range,[1] a measure of the amount by which byproducts (BRI) and emissions (ERI) have changed for that chemical in that production unit, a base year from which the BRI and ERI are calculated, and, if the BRI shows a 5 percent or more improvement over the prior year's BRI, codes are reported that indicate what TUR techniques were used to achieve that progress.

Figure F-1 illustrates how this structure is reflected in the data reported by a hypothetical facility. At the chemical level, in 1990, the facility 'otherwise used' a total of 100,000 lbs of toluene and generated 100,000 lbs of toluene byproduct. No toluene was manufactured,

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[1]The range codes are: A = 0 to 5,000 lbs; B = > 5,000 lbs to 10,000 lbs; and C = > 10,000 lbs.

1990 Data

Chemical Record

Facility: XYZ Finishing Inc.		Chemical: Toluene	
Manufactured	0	Gen. Byproduct	100,000
Processed	0	Shipped in Product	0
Otherwise Used	100,000		

Production Unit Record

Facility: XYZ Finishing Inc.			
Production Unit	1	2	3
Product	Fuses	Metal Parts	Ball Bearings
Process	Fuse Manufact.	Degreasing	Bearing Manufact.
SIC Codes	3643,3629	3469	3499

Chemical - Production Unit Record

Facility: XYZ Finishing Inc.		Chemical: Toluene
Production Unit:	1	3
Base Year	87	90
Quantity Code	C	C
BRI	N/A	N/A
ERI	N/A	N/A
TUR Codes		

1991 Data

Chemical Record

Facility: XYZ Finishing Inc.		Chemical: Toluene	
Manufactured	0	Gen. Byproduct	150,000
Processed	0	Shipped in Product	0
Otherwise Used	150,000		

Production Unit Record

Facility: XYZ Finishing Inc.			
Production Unit	1	2	3
Product	Fuses	Metal Parts	Ball Bearings
Process	Fuse Manufact.	Degreasing	Bearing Manufact.
SIC Codes	3643,3629	3469	3499

Chemical - Production Unit Record

Facility: XYZ Finishing Inc.		Chemical: Toluene
Production Unit:	1	3
Base Year	87	90
Quantity Code	C	C
BRI	-11%	50%
ERI	-11%	50%
TUR Codes		51,81

Figure F-1

processed or shipped in the product of this facility. The following year, use and byproduct increased to 150,000 lbs.

At the production unit level, the facility has a diverse business and has chosen to divide the facility, for reporting purposes, into three different production units. One production unit makes fuses, another makes metal ball bearings and one is a metal parts degreaser. Production unit 1 has two industry codes. SIC code 3643 is listed first since it is the primary industry for the production unit. The other two production units each only have one SIC code, both different from that of production unit 1.

At the chemical-production unit level, the toluene is used in only two of the production units, 1 and 3. The BRI for Unit 1 is calculated from a base year of 1987 while the BRI for Unit 3 is calculated from 1990. The BRIs show that, in 1991, more byproduct was generated per unit of product in unit 1 and less byproduct was generated per unit of product in unit 3.[2] The use codes, C, indicate that the toluene was used in quantities above 10,000 lbs in both production units. There is no way to tell from the chemical-production level information how the use is split. It could be split fairly evenly between the two units or one unit could account for the majority of the use.

2 Specific Examples of Data Structure Issues

2.1 Using BRI to Measure TUR Progress

The structure of the TURA data does not allow the BRIs or TUR codes to be used to measure progress in most cases. This is because there is no indication of how the BRI or TUR code related to the chemical quantity and therefore no way to tell whether a particular BRI or TUR code is responsible for a significant change in quantity.

The TURA data in Figure F-1 provide an example of this issue. Because the Quantity Code is "C" for both production units, it is possible that Production Unit 1, with a BRI of -11%, is responsible for either 135,000 lb or 15,000 lb out of the total 150,000 lb of toluene use. Therefore, a facility-wide weighted average BRI could be as low as -5% or as high as +44%.

As described in the body of report, when a chemical is used in more than one production unit, the BRIs can not be used to measure progress. However, when a chemical is used in only one production unit, it is, in effect, the facility-wide BRI for the chemical. Chemical-production units which fall into this category are used in Universe 2 to measure state-wide progress with BRIs. (See Chapter 8 and Appendix I for more detailed explanation on Universe 2.)

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[2] A positive BRI is 'good', it shows increasing effectiveness while, a negative BRI is 'bad", it shows that the chemical is being used less effectively, i.e. more is being wasted.

2.2 Using Production Unit SICs to Measure Industry Progress

The TURA data structure also makes it difficult in many cases to measure progress for specific industries. TURA facilities report one or several SIC codes at the production unit level. This provides a precise information about the types of production units used in various industrial sectors. However, because the chemical quantities are reported for the entire facility, the quantities can not be attributed accurately to specific industries.

In the example given in Figure F-1, the facility use 100,000 pounds of toluene in 1990. The use is split between two different production units with three different SIC codes, 3643, 3629, and 3499. The primary SIC codes are 3643 and 3499. Because the Quantity Code for both production units is C, there is no way to tell how to apportion the use between the industries. If the full amount of use is included in an analysis by 4-digit SIC code, then 100,000 lb of toluene is added to totals for both SIC 3643 and 3499. This results in "double counting" of the quantity, and an overstatement of the chemical quantities actually attributable to each industrial sector. A still greater overstatement results when all SIC codes listed are used, rather than the just the primary SIC code for each production unit.

2.3 Using TUR Techniques to Measure Industry Progress

The number of TUR codes reported by a company had been proposed as a qualitative measure of TUR activity. However, simply counting the number of TUR technique codes reported for each production unit can overstate the amount of TUR activity. For example, the facility in Figure F-1 changed an operations and maintenance procedure, such as how toluene is stored and dispensed, which reduced the quantity of waste. Because this one change applies to all the uses of toluene, it would be reported for each production unit. If there were two BRI's greater than 5%, the data would show that activity 81 occurred twice. If the facility had chosen to break the production process down into 20 units, the activity 81 could have been reported as many as 21 times. This gives the appearance of more TUR activity than may actually be occurring.

The TUR codes also give no indication of how much TUR was associated with each code. It is often difficult to classify process changes; several TUR codes may apply. Therefore, a small improvement could have several TUR codes, while a large-scale input substitution could have just one TUR code.

2.4 Incomplete Records

Incomplete records are records that do not have all three levels of information (chemical, production unit, and chemical-production unit) in the extract files. Figure F-2 shows an example of this type of problem. The records on the left show what a complete record would look like. The records on the right are for the same information with some portions missing. Production Unit 1 is missing the Production Unit level information, Production Unit 2 is missing

Complete Record

Chemical Record

Facility : ABC Metals Inc.		Chemical: Toluene	
Manufactured	0	Gen. Byproduct	200,000
Processed	0	Shipped in Product	0
Otherwise Used	200,000		

Production Unit Record

Facility: ABC Metals Inc.				
Prod. Unit	1	2	3	4
Product	Wire	Wire	Ball Bearing	Metal Parts
Process	Degrease	Bending	Wastewater Treat.	Stamping
SIC Codes	3643	3629	3499	3499

Chemical - Production Unit Record

Facility: ABC Metals Inc.		Chemical: Toluene		
Production Unit:	1	2	3	4
Base Year	87	90	90	91
Quantity Code	C	C	C	C
BRI	-200	25	5	50
ERI	-200	25	5	50
TUR Codes		51,81	51,81	51,81

Incomplete Record

Chemical Record

Facility : ABC Metals Inc.		Chemical: Toluene	
Manufactured	0	Gen. Byproduct	200,000
Processed	0	Shipped in Product	0
Otherwise Used	200,000		

Production Unit Record

Facility: ABC Metals Inc.				
Prod. Unit	1	2	3	4
Product	*missing*	Fuses	*missing*	Metal Parts
Process	*missing*	Degreasing	*missing*	Stamping
SIC Codes	*missing*	36293643	*missing*	3499

Chemical - Production Unit Record

Facility: ABC Metals Inc.		Chemical: Toluene		
Prod Unit:	1	2	3	4
Base Year	87	*missing*	*missing*	91
Quantity Code	C	*missing*	*missing*	C
BRI	-200	*missing*	*missing*	50
ERI	-200	*missing*	*missing*	50
TUR Codes		*missing*	*missing*	51,81

Figure F-2

the Chemical-Production Unit level information, and there is no information at all for production unit 3.[3]

Whereas the records on the left in Figure F-2 show that 200,000 lbs of toluene were used in four different production units, for the records on the right it appears that 200,000 lbs of toluene were used in only two production units, number 1 and 4. However, production unit 1 is missing the production unit level information. For the methodology, this would give the impression that the entire 200,000 pounds of toluene was used in SIC code 3499 and that the 50% BRI was related to the entire 200,000 pounds.

2.5 Incomplete Metal Bender Exemption Records

Metal Bender Exemptions are for metalworking facilities that process copper or steel (nickel, chromium, and manganese) only by changing the shape of the solid metal, have an aggressive scrap metal recycling program, and have no federal Form R reportable releases of the metal other than transfers to a recycler or scrap broker. This exemption was first available in 1993. Although these facilities are still required to report under TURA, they only submit a Form R, a Form S coversheet, and Section 1 of the Form S for the metal. They are not required to pay a filing fee or file a TUR plan for the exempted metal. There are two major problems with the reporting procedures for metal benders.

First, during the first years of metal bender claims, there was a considerable amount of confusion about which metals exemptions were being claimed for. Because the DEP did not have this information readily available, and there was confusion about how the information would be handled in FMF, the 1993 information for metal benders was not available until August 1995, nine months after the other 1993 data was released. At this time, there are still a few metal benders for which TURA data is not available for the years 1991, 1992 and 1993, with most of the missing records in 1993. The result of this problem is that the extract files appear to show a decrease in chemicals in 1993, but, in fact, it is due only to information missing from the extract files. The amount of this material missing is difficult to determine but is probably in the range of 12 to 17 million pounds in 1991 and 1992 and 5 million pounds in 1993.

Furthermore, it is not possible to determine from the extract files which facilities have requested a metal bender exemption or for what chemicals exemptions have been requested. It is difficult to clarify this issue, because the information is not readily available at DEP.

Second, since the facilities are only required to fill out Section 1 of the Form S when submitting for an exempted metal, there is no Chemical-Production Unit record and therefore no link to the

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[3] Note that this is an example only. Most incomplete records would only have one of these problems. All three are shown here in one record for illustration only.

industry SIC code in the Production Unit record. This means that use information for exempted metals can not be tracked by industry from 1993 onward. Because the metal bender exemption was not available until 1993, the 1990-1992 extract files include the exempted metals (except as noted above). The amount processed in these years is in the range of 74 to 83 million pounds of chemicals (mostly copper). These quantities cannot be tracked by industry in 1993 and therefore those industries appear to have a significant decrease in amount of chemical processed in 1993. In addition, when progress is measured for the specific chemicals the data shows incorrectly that significant TUR progress has been made for these chemicals.

2.6 Incomplete Wastewater Treatment Production Units Records

Facilities that use listed chemicals to treat wastewater are required to include the quantity so used in calculating the total amount of the listed chemical used at the facility and report that total in Section 1 of the Form S (Chemical level record). They are also supposed to answer 'Yes' to the question in Section 2 of the Form S 'Is this chemical used to treat waste or control pollution?' and include a code for the amount used to treat waste.[4]

Since the chemicals are used in quantities as high as 27 million pounds, the amount code ranges are not very useful. Facilities have the option to enter the exact amount used to treat waste but that option is not consistently exercised. The facility is not required to fill out Sections 3 of the Form S for wastewater treatment production units nor are they required to include information on the Form S Coversheet Production Unit record section for wastewater treatment units.

Because of this reporting procedure, if a chemical is used only for wastewater treatment at a facility, the amount used is reported by the facility but no production unit information is provided and the record is incomplete. The result is that the use of the chemical can not be tracked by industry. In addition, since there is no BRI information, there is no indication of TUR activity for wastewater treatment chemicals.

If a chemical is used both in wastewater treatment and in a production unit, there is no indication of how much should be attributable to each process. It could be a significant distortion of progress to assume that the production unit (and its BRI) applies to the entire quantity reported. In addition, there were many instances where facilities had reported production units which were wastewater treatment, although DEP instructs facilities not to do so.

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[4] The amount codes are the same as those mentioned previously:
A = 0 to 5,000 lbs; B = > 5,000 lbs to 10,000 lbs; and C = > 10,000 lbs

FACILITY: ID: TOWN:

SURVEY TO MEASURE PROGRESS FROM 1987

The purpose of this survey is for DEP to develop a rough estimate of the 1987 chemical use and byproduct levels. We do NOT expect anyone to conduct an extensive research project or hire an outside TURP to do any of the work. If this is necessary, please do not participate in this survey.

QUESTIONS TO BE ASKED OF EVERY FIRM CONTACTED

1. Are you the TURA contact at your facility, or is there another contact at your facility?
   Yes:_____ Position:__________________Please go to # 3
   No: _____ Please go to question #2

2. Who is the TURA contact?
   Name:__________________ Position:__________________
   Telephone number:______________________
   Inside house:_____
   Outside:_____

3. How long have you held your current position?
   Years:_______

4. Did your facility have 10 FTE's in 1987?
   Yes:_____
   No: _____

5. If you worked at your facility any time between 1987 and 1989, were you responsible/ would you have been responsible for reporting TRI information?
   Yes:______ Please go to # 7
   No: ______ Please go to # 6

6. Is the person that was responsible for reporting between 1987 and 1989 still working at your facility?
   Yes:_____ Name:_______________Position:_____________________
   No: _____

7. How accurate do you feel the information was during reporting years 1987 to 1989?

8. We are interested in whether production levels changed significantly between 1987 and _________[the first year we have reporting data for your facility]. By what percent do you think they increased or decreased during this time period?

9. We are interested in whether there were any significant changes in your production processes or product formulations between 1987 and ________[the first year we have reporting data for your facility] that could have influenced toxic chemical use or byproduct generation.

Yes:_____ What were they?
No :_____

10. Did your facility engage in any pollution prevention activities between 1987 and 1989?

Yes:_____ Please go to #11
No :_____ Please go to #12

11. Was 1987 used as a baseline for any of your production processes?

Yes:_____ For what chemicals:

No: _____ Why?

12. Were there any other factors that would have influenced your byproduct generation? (for example, facility shut down for a significant time period)

RECYCLING QUESTIONS

The chart below lists each TURA chemical that you reported recycling.
For each chemical DEP has the following information:

* The first year you submitted recycling information to DEP
* The pounds you recycled (combined on site, off site, and energy recovery) the first year your facility submitted recycling information to DEP.

Please indicate on the chart below the corresponding recycling data for 1987.

In addition, could you please indicate the accuracy of your estimate: very accurate ; accurate; rough estimate; not reliable.

	RECYCLE		
	LBS		LBS 1987
CHEMCIAL NAME: YEAR:			
ACCURACY: Very accurate:	Accurate:	Rough Estimate:	Not Reliable:
CHEMICAL NAME: YEAR:			
ACCURACY: Very accurate:	Accurate:	Rough Estimate:	Not Reliable:
CHEMICAL NAME: YEAR:			
ACCURACY: Very Accurate:	Accurate:	Rough Estimate:	Not Reliable:

CERCLA QUESTIONS

The chart below lists each CERCLA chemical your facility submitted data to DEP. For each chemical, DEP has the following information:

* The first year you facility submitted data for that chemical
* The pounds of use
* The pounds of byproduct generated
* The pounds transferred/released

Please indicate on the chart below the corresponding data for 1987.

In addition, could you please indicate the accuracy of your estimate: very accurate; accurate; rough estimate; not reliable.

	USE		BYPRODUCT		TRANSFERS & RELEASES	
	FIRST YEAR LBS	LBS 1987	FIRST YEAR LBS	LBS 1987	FIRST YEAR LBS	LBS 1987
CHEMICAL: YEAR:						
Accuracy:	Very Accurate:		Accurate:	Rough Estimate:		Not Reliable:
CHEMICAL: YEAR:						
Accuracy:	Very Accurate:		Accurate:	Rough Estimate:		Not Reliable:
CHEMICAL: YEAR:						
Accuracy:	Very Accurate:		Accurate:	Rough Estimate:		Not Reliable:

FACILITIES WITH NO TRI DATA SUBMITTED IN 1987

The chart below lists each TURA chemical your facility submitted data to DEP. For each chemical , DEP has the following information:

* The first year your facility submitted data for that chemical
* The pounds of use
* The pounds of byproduct generated
* The pounds transferred/ released

Please indicate on the chart below the corresponding data for 1987

In addition, could you please indicate the accuracy of your estimate: very accurate; accurate; rough estimate; not reliable.

	USE		BYPRODUCT		TRANSFERS/RELEASES	
	FIRST YEAR LBS	LBS 1987	FIRST YEAR LBS	LBS 1987	FIRST YEAR LBS	LBS 1987
CHEMICAL: YEAR:						
Accuracy:	Very Accurate:	Accurate:	Rough Estimate		Not Reliable:	
CHEMICAL: YEAR:						
Accuracy:	Very Accurate:	Accurate:	Rough Estimate:		Not Reliable:	
CHEMICAL: YEAR:						
Accuracy:	Very Accurate:	Accurate:	Rough Estimate:		Not Reliable:	
Chemical:						
Accuracy:	Very Accurate:	Accurate:	Rough Estimate:		Not Reliable:	

Appendix G2 - Details of 1987 Baseline Surveys

A. Details of Pilot Survey to Establish 1987 Baseline

Results as of August 9, 1995

DEP SURVEY PROCESS

- Compile data for each specific company
- Make initial contact
- Fax survey
- Answer questions/provide further explanation
- Take answers over the phone

Survey dates:	August 2, 1995 - August 8, 1995	
Hours Spent:		18
Companies in sample:		25
Companies with which we made contact: (one facility has ceased operating)		24
Companies reached with one call		15
Companies reached with two calls		7
Companies reached with three or more calls		2
Companies in which appropriate person was reached: (Five contacts were on vacation, one facility was dropped because the data was unclear, one facility had no appropriate contact).		17
Companies which agreed to participate:		17
Completed surveys		4
Companies providing immediate answers on phone:		3
Companies answering on phone after receiving fax:		2
Companies with partial response:		1
Companies that had no data:		1
Companies asking for survey to be faxed:		11
Companies that agreed to do survey but had not called back yet:		1

B. Details of Full Survey

DEP has begun the survey with the top twenty facilities in Massachusetts and those randomly chosen from the Recycle list. The remainder of the facilities will be surveyed in the near future and the results will be made available.

<u>Top 20 Survey</u>

Survey dates:	Oct. 5, 1995 - Nov. 13, 1995
Facilities contacted:	14
Facilities not applicable - didn't fit survey criteria	2
Facilities closed	3
Facilities that had already given DEP necessary data without survey	1
Facilities that completed the survey	11
Facilities that had not responded to survey as of November 13, 1995	3
Facilities that responded with 1 call	5
Facilities that responded with 2 calls	1
Facilities that responded with 3 or more calls	6

<u>Recycle list Survey</u>

Initial contact to 43 of the 60 recycle facilities had been completed as of November 13, 1995. These are the results at this time:

Survey dates: Oct. 17, 1995 - Nov. 13, 1995

Facilities that data has been collected to survey	50
Facilities that have been contacted	43
Facilities that DEP has not contacted	7
Facilities that remain for data collection and survey	10
Facilities that have completed survey	18
Facilities that cannot complete survey- no one available at facility at this time	1
Facilities that will not complete survey because they considered it to be too much work	2
Facilities that responded with one call:	10
Facilities that responded with two calls:	4
Facilities that responded with three or more calls:	3

Appendix H - TURA DATA ISSUES

Introduction

DEP's Data Exception reports and TURI's Data Consistency reports identified issues with TURA data in the areas of data quality, reporting practices and FMF system utilities. Many of those issues have been resolved or are scheduled to be fixed by the next data release. Other issues have yet to be resolved and scheduled for fixing. This appendix briefly describes the status of the issues identified and the schedule for fixing problems that still exist.

The types of problems that the Data Exception report identifies include:

- Byproduct quantity greater than total use
- Byproduct quantity less than total TRI transfers and releases
- Byproduct quantity greater than total TRI transfers and releases when there is no destructive treatment of the waste
- BRIs that are greater than 100 or very negative

The report flags all data that could potentially be in error. DEP verifies that the data was entered correctly. Data entry errors are corrected. Facilities are notified of data that appears to be in error and requested to submit corrected Forms S and R.

The DEP has currently run the exception report on all 1990, 1993 and 1994 data. Facilities have been notified of any problems found. Data entry errors will be corrected in the next data release and facility corrections will be entered as they are received. The DEP has checked some of the 1991 and 1992 data manually and corrected errors found or notified facilities of problems.

The TURI Data Consistency reports have been run on all the data in the extract files (1990 through 1993). In addition to flagging the types of errors mentioned above, the TURI reports also look for problems with:

- incomplete records
- inconsistently reported facility ID numbers, names, locations, and production unit numbers
- invalid or unexpected values (production ratio less than zero or much greater than 10 without a corresponding change to use and byproduct)
- problems with the extract files
- SIC code anomalies

The November 1994 data release contained many of these issues, some of which were corrected in the August 1995 data release. The remaining problems are expected to be corrected in the January 1996 data release.

Resolved Issues

A number of problems with the extract program identified in the November 1994 data release were resolved in the April 1995 release. These include:

- The extract program was creating duplicate records in the extract files - in one case over 10,000 records were added to a file. The extract program was fixed.
- Blank records or nearly blank records created by the extract program.
- The information about which SIC code was the primary SIC code for a production unit was not included in the extract files. This was fixed by adding a new field "Primary SIC" to the production unit file with a "Y" if the SIC code was the primary and an "N" if it was not.

In addition, the August 1995 data release included corrected form S and R data received from facilities through June of 1995

Issues Scheduled to be Fixed

The following problems are expected to be fixed in the next data release

- Correctly 'zeroing out' existing 'no delete' records
- Data entry errors
- Facilities with one year's data entered twice under different ID numbers
- Facilities entered under different ID numbers in different years
- Data not entered for all Metal Bender Facilities
- Records incomplete because of data entry error

In addition, facilities have been notified of known or suspected facility reporting errors and have been requested to submit corrected reports. These will be fixed as they are received from the facilities.

Issues Not Yet Resolved

Some problems are still being verified by DEP or the appropriate solution has not yet been identified. These include:

- duplicate key records
- no delete function
- metal bender production units not entered
- wastewater treatment chemicals

Appendix I - TURA UNIVERSES

Universes

The data reported by TURA filers from 1990 through 1993 included many inconsistencies due to the phasing in of industries and chemicals and due to changing circumstances at reporting facilities. There were also anomalies in the data caused by data issues described in Chapters 3 and 4. In order the measure progress, the methodology took these inconsistencies into account by creating separate subsets or 'universes' of data. Each universe had a specific purpose in the methodology. This appendix describes what records were included in each universe, the purpose of the universe, and other characteristics of each universe such as the size and the weighted average production ratio.

The TURA regulations included a phase-in period for TURA filers based on the type of facility and the chemicals used. In 1990, only manufacturing facilities (SIC codes 20 through 39) were required to report. Facilities in the non-manufacturing SIC codes were required to report beginning in 1991. For chemicals, the original list of TURA chemicals were required to be reported in 1990. From 1991 to 1993, a third of the CERCLA chemicals were added each year. In order to allow for the phasing-in of filers and chemicals, most of the universes included only chemicals or facilities reportable in specific years.

Another inconsistency with the TURA data involves trade secret data. Facilities are allowed to claim that TURA information needs to be kept confidential. In this case, the facility files the required forms but the data is not made available to anyone outside of DEP. This causes problems with the methodology when a facility reports a chemical in one or more years and then claims it as trade secret in following years. This causes the appearance of a decrease in reported quantities when in fact it is only a decrease in what is available for analysis in the extract files and standard reports. Any chemicals that were claimed trade secret in any year were excluded from all of the methodology universes, except "All TURA."

Some data errors described in Chapter 4 cause problems with the methodology. These included duplicate key records, duplicate facilities, 'no delete' records, and records with incomplete production unit level information. These records were excluded from some of the universes depending on which data elements were being utilized.

Table I-1 shows the ten different universes of TURA data examined and what types of records were included in each one. The text following the table describes more fully what aspects of the TURA data each universe can be used to examine. In Appendix J are summary reports for each universe. The summary report shows the number of facilities, chemicals, and records included in each universe as well as the different quantities reported for facilities and chemicals in that universe. Weighted average production ratios for each universe and the portion of the universe that was used to calculate it, are included at the end of this Appendix.

TURA Data Universes

	Universe										
	All TURA	0	1	2	3	4	5	6	7	8	9
Duplicate Keys											
Trade Secret Inconsistencies	x										
No Deletes	x										
Duplicate Facilities	x										
Production Unit Inconsistencies	x	x			x	x	x	x	x	x	x
90 Reportables	x	x	x	x	x	x	x	x	x		
91 Reportables	x						x	x	x	x	
9[illegible] Reportables	x							x	x		x
93 Reportables	x										

Table I-1 An 'x' means that those records are included in a universe.

All TURA - This universe included all chemical records that were in the DEP extract files with the exception of duplicate key records, (less than 3 million pounds in all years). This universe show the total amount in the extract files but can not be used for measuring progress because of the many inconsistencies previously described.

Universe 0 "1990 Reportables" - This universe includes records for any chemical and facility that would have been required to report in 1990, regardless of whether or not the facility actually reported the chemical in 1990. This universe contains approximately 65 percent of all facilities reporting annually and over 90 percent of the chemical amounts reported. It is the largest "consistent" universe available in the extract files.

Universe 1 "1990 Reportables with Consistent Production Unit Data" - This universe is a subset of universe 0 that excludes the quantities for any record that was incomplete (missing production unit or BRI type information). It was developed to measure progress for specific industries, and to do other production unit-level analysis.

Universe 2 "Single Consistent Production Unit/Chemical/Facility - This universe was a subset of Universe 1. It included any 1990 Reportable Chemicals and SIC facilities for which one and only one Production Unit/Chemical/Facility was reported consistently over all four years. Where only one production unit is reported, the production unit BRI and ERI are the same as the facility-wide chemical BRI and ERI. These records can be used to generate a state-wide aggregated BRI.

This universe contains 40 percent of the facilities reporting annually, one third of the total use, and 20 percent of the generated byproduct.

Universe 3 "Consistent Facility/Chemical" - This universe was a subset of Universe 0. It included any 1990 reportable Chemicals and SIC facilities where the same chemical was reported by the facility for every year from 1990 to 1993. This universe calculation of trends for a group of facilities and chemicals which were always reported. It will assist in understanding the effect on the measurement of progress of chemicals rising above and dropping below the reporting threshold. The universe contains over 65 percent of the facilities reporting annually, over 60 percent of the total use and generated byproduct.

Universe 4 "Consistent Facility" - This universe is a subset of Universe 0. It included all records for 1990 Required chemicals reported by a facility that reported at least one 1990 Required Chemicals/SICs in all four years, 1990-1993. By examining the trends of facilities that reported consistently, this universe allows testing whether facility movement into and out of the reporting universe affects the overall trends. This universe includes over 65 percent of the facilities annually reporting and over 80 percent of the total use and generated byproduct.

Universe 5 "Year to Year Change 1990 - 1991" - This universe included all records for chemicals/SIC level production units that were reportable and reported in 1990 and 1991. This universe is a subset of Universe 0. It includes only records that were reported in both 1990 and 1991 so that an accurate weighted average production ratio can be calculated. It can only be used to measure change from 1990 to 1991.

Universe 6 "Year to Year Change 1991 - 1992" - This universe included all chemicals that were reportable and reported by a facility in 1991 and 1992. It includes all 1990 and 1991 reportable chemicals as well as both manufacturing and non-manufacturing SICs. It is similar to Universe 5, but is used to measure change from 1991 to 1992.

Universe 7 "Year to Year Change 1992 - 1993" - This universe includes all chemicals that were reportable and reported by a facility in 1992 and 1993. It includes all 1990, 1991, and 1992 reportable chemicals and both manufacturing and non-manufacturing SICs. It is similar to Universe 5, but is used to measure change from 1992 to 1993.

Universe 8 "1991 Reportables" - This universe includes only records for chemicals and facilities that first became reportable in 1991. It provides a measure of the progress for these chemicals from 1991 to 1993. It can only be used to measure progress from 1991 to 1993.

Universe 9 "1992 Reportables" - This universe includes only records for chemicals and facilities that first became reportable in 1992. It provides a measure of the progress for these chemicals from 1992 to 1993. It can only be used to measure progress from 1992 to 1993.

Because there is only 1993 data for chemicals that first became reportable in 1993, no analysis was done on progress for these chemicals. They will be added to the methodology when another year's worth of data is available.

Weighted Average Production Ratios

A weighted average production ratio (PR_{WA}) was calculated for applicable years for each of the universes. The results for all universes or subsets of universes are shown in table I-2.

Weighted Average Production Ratios for Universes

	1991	1992	1993
Universe 0 - 1990 Reportables	0.972	0.991	1.061
Subset of Universe 0 - Top "20" Facilities	0.948	0.955	1.062
Subset of Universe 0 - Non Top "20" Facilities	1.040	1.077	1.061
Universe 1 - Complete Universe 0 Records	0.983	0.992	1.071
Universe 2 - Single Production Unit Chemicals	N/A	N/A	N/A
Universe 3 - Consistent Chemicals	0.970	0.975	1.066
Universe 4 - Consistent Facilities	0.972	0.986	1.067
Universe 5 - Reported in 1990 and 1991	0.972	N/A	N/A
Universe 6 - Reported in 1991 and 1992	N/A	0.987	N/A
Universe 7 - Reported in 1992 and 1993	N/A	N/A	1.065
Universe 8 - 1991 Reportables	N/A	0.945	1.108
Universe 9 - 1992 Reportables	N/A	N/A	1.055

Table I-2

The PR_{WA} can only be calculated from records that have two consecutive years worth of data and a production ratio greater than zero in the second year. Since not all records in a universe fit this criteria, the percent of the data used to calculate a PR_{WA} varied from one universe to another. Table I-3 shows the percent of each universe's total use that figured into the PR_{WA}.

Percent of Total Use used to Calculate PR_{WA}

	1991	1992	1993
Universe 0 - 1990 Reportables	87	93	97
Subset of Universe 0 - Top "20" Facilities	96	97	96
Subset of Universe 0 - Non Top "20" Facilities	70	86	89
Universe 1 - Complete Universe 0 Records	88	94	97
Universe 2 - Single Production Unit Chemicals	N/A	N/A	N/A
Universe 3 - Consistent Chemicals	95	97	99
Universe 4 - Consistent Facilities	91	96	98
Universe 5 - Reported in 1990 and 1991	94	N/A	N/A
Universe 6 - Reported in 1991 and 1992	N/A	91	N/A
Universe 7 - Reported in 1992 and 1993	N/A	N/A	89
Universe 8 - 1991 Reportables	N/A	77	69
Universe 9 - 1992 Reportables	N/A	N/A	85

Table I-3

01/08/96 Total Chemical Amounts Reported on Form S and R (ALLCHEMS.RSL) Page 1

Release Date:8/29/1995 Universe : All TURA All Reporting Facilities and Chemicals

	1990	1991	1992	1993
TURA Information				
Manufactured Amount :	25,806,774	15,257,099	20,405,477	19,862,748
Processed Amount :	764,961,043	845,970,088	821,773,637	806,688,917
Otherwise Used Amount :	136,380,491	151,644,838	191,439,678	188,488,448
Total Use Amount:	927,148,308	1,012,872,025	1,033,618,792	1,015,040,113
Generated Byproduct Amt :	114,214,580	135,144,852	144,588,903	137,052,977
Shippped in/as Prod Amt :	329,044,771	453,459,967	432,253,186	483,678,133
TRI Information				
Total Emissions :	20,927,774	20,751,689	17,067,110	14,413,618
Discharge to POTW Amt:	3,398,098	2,143,012	4,253,702	3,744,043
Transfer Offsite Amt:	11,896,268	32,292,654	37,870,064	36,537,456
Total Releases and Transfers:	36,222,140	55,187,355	59,190,876	54,695,117
General Information				
Number of Facilities :	677	719	698	654
Number of Chemicals :	129	146	160	179
Number of Records :	2,110	2,363	2,513	2,503

Release Date:8/29/1995 Universe : Univ-0 All Chemicals/SICs Reportable in 90

	1990	1991	1992	1993
TURA Information				
Manufactured Amount :	25,531,959	7,444,207	8,500,285	6,322,692
Processed Amount :	753,479,769	723,791,014	658,024,794	637,016,428
Otherwise Used Amount :	126,948,628	124,461,342	121,074,364	111,014,677
Total Use Amount:	905,960,356	855,696,563	787,599,443	754,353,797
Generated Byproduct Amt :	110,369,343	112,328,998	105,833,339	96,552,630
Shippped in/as Prod Amt :	318,173,895	344,760,629	320,858,622	334,632,394
TRI Information				
Total Emissions :	20,723,828	17,010,102	14,614,308	11,320,847
Discharge to POTW Amt:	3,188,173	1,708,104	1,864,793	1,479,757
Transfer Offsite Amt:	11,486,742	29,685,722	35,249,554	33,774,797
Total Releases and Transfers:	35,398,743	48,403,928	51,728,655	46,575,401
General Information				
Number of Facilities :	663	641	629	572
Number of Chemicals :	110	109	110	101
Number of Records :	1,985	1,933	1,898	1,697

Release Date:8/29/1995 Universe : Univ-1 Complete 90 Reportable Chemicals & SICs

	1990	1991	1992	1993
TURA Information				
Manufactured Amount :	25,377,538	7,188,008	7,810,425	5,876,274
Processed Amount :	727,341,347	702,655,041	633,175,691	594,255,917
Otherwise Used Amount :	112,351,313	114,254,972	114,526,858	107,110,674
Total Use Amount:	865,070,198	824,098,021	755,512,974	707,242,865
Generated Byproduct Amt :	107,010,186	109,941,381	101,793,937	93,707,459
Shippped in/as Prod Amt :	281,639,496	322,287,067	297,410,531	297,324,524
TRI Information				
Total Emissions :	20,331,316	16,793,541	14,417,012	11,142,824
Discharge to POTW Amt:	3,051,554	1,480,286	1,657,283	1,190,564
Transfer Offsite Amt:	11,190,542	28,303,771	32,514,336	32,089,094
Total Releases and Transfers:	34,573,412	46,577,598	48,588,631	44,422,482
General Information				
Number of Facilities :	637	621	602	545
Number of Chemicals :	109	108	108	98
Number of Records :	1,874	1,838	1,790	1,589

Release Date:8/29/1995 Universe : Univ-2 Consistent Single-PU Chemicals

	1990	1991	1992	1993
TURA Information				
Manufactured Amount :	13,126,176	3,405,814	3,563,289	2,316,505
Processed Amount :	531,652,394	502,703,753	420,883,259	404,972,031
Otherwise Used Amount :	40,574,010	60,930,878	58,988,508	61,694,162
Total Use Amount:	585,352,580	567,040,445	483,435,056	468,982,698
Generated Byproduct Amt :	47,642,201	46,904,750	44,674,229	44,852,855
Shippped in/as Prod Amt :	192,402,027	210,918,492	186,313,719	202,392,594
TRI Information				
Total Emissions :	7,136,700	6,475,541	5,582,638	4,814,960
Discharge to POTW Amt:	1,830,166	687,942	588,060	481,092
Transfer Offsite Amt:	4,984,529	10,503,274	12,648,707	14,705,248
Total Releases and Transfers:	13,951,395	17,666,757	18,819,405	20,001,300
General Information				
Number of Facilities :	325	325	325	325
Number of Chemicals :	78	78	78	78
Number of Records :	692	692	692	692

Release Date:8/29/1995 Universe : Univ-3 Facility/Chemical Reported All 4 Years

	1990	1991	1992	1993
TURA Information				
Manufactured Amount :	21,631,784	5,761,982	5,410,707	4,220,911
Processed Amount :	686,215,324	643,353,227	570,673,236	547,365,495
Otherwise Used Amount :	98,496,176	101,064,810	98,742,555	95,251,275
Total Use Amount:	806,343,284	750,180,019	674,826,498	646,837,681
Generated Byproduct Amt :	89,367,043	90,174,987	84,825,723	82,637,014
Shippped in/as Prod Amt :	265,697,946	280,191,265	255,143,618	268,117,235
TRI Information				
Total Emissions :	11,931,921	11,091,884	9,845,458	8,563,493
Discharge to POTW Amt:	2,524,116	1,085,643	1,010,834	879,381
Transfer Offsite Amt:	8,406,775	22,888,573	26,634,611	26,332,482
Total Releases and Transfers:	22,862,812	35,066,100	37,490,903	35,775,356
General Information				
Number of Facilities :	421	421	421	421
Number of Chemicals :	84	84	84	84
Number of Records :	1,089	1,089	1,089	1,089

Release Date:8/29/1995 Universe : Univ-4 Facilities Reporting All 4 Years

	1990	1991	1992	1993
TURA Information				
Manufactured Amount :	25,032,451	6,058,629	7,928,316	5,893,080
Processed Amount :	715,846,461	686,636,844	619,612,736	598,436,935
Otherwise Used Amount :	117,854,634	112,520,785	108,834,692	101,293,797
Total Use Amount:	858,733,546	805,216,258	736,375,744	705,623,812
Generated Byproduct Amt :	103,784,546	102,334,246	98,057,355	90,391,108
Shippped in/as Prod Amt :	287,517,755	310,039,109	288,114,442	298,402,336
TRI Information				
Total Emissions :	17,752,660	14,611,160	12,493,496	9,742,181
Discharge to POTW Amt:	2,976,679	1,457,900	1,649,103	1,241,953
Transfer Offsite Amt:	10,451,736	27,181,920	31,454,881	30,222,832
Total Releases and Transfers:	31,181,075	43,250,980	45,597,480	41,206,966
General Information				
Number of Facilities :	446	446	446	446
Number of Chemicals :	106	107	108	98
Number of Records :	1,608	1,595	1,559	1,457

Release Date:8/29/1995 Universe : Univ-5 Facility/Chemicals Reported in 90 and 91

	1990	1991	1992	1993
TURA Information				
Manufactured Amount :	25,313,367	6,623,071	5,876,907	4,220,911
Processed Amount :	712,931,282	668,989,960	584,345,183	548,786,082
Otherwise Used Amount :	113,645,310	114,470,579	106,000,766	95,639,371
Total Use Amount:	851,889,959	790,083,610	696,222,856	648,646,364
Generated Byproduct Amt :	102,323,194	102,647,929	91,633,288	82,919,980
Shippped in/as Prod Amt :	282,993,677	299,337,127	266,815,387	269,444,960
TRI Information				
Total Emissions :	17,655,485	15,446,694	12,035,706	8,627,714
Discharge to POTW Amt:	2,882,760	1,412,849	1,127,418	880,081
Transfer Offsite Amt:	10,163,988	26,763,028	29,334,004	26,629,789
Total Releases and Transfers:	30,702,233	43,622,571	42,497,128	36,137,584
General Information				
Number of Facilities :	552	552	497	424
Number of Chemicals :	96	96	89	85
Number of Records :	1,543	1,543	1,355	1,111

Release Date:8/29/1995 Universe : Univ-6 Facility/Chemicals Reported in 91 and 92

	1990	1991	1992	1993
TURA Information				
Manufactured Amount :	25,614,959	12,787,139	11,366,650	6,666,172
Processed Amount :	757,590,682	824,613,167	759,272,220	746,556,641
Otherwise Used Amount :	128,837,628	146,618,068	141,632,684	133,745,143
Total Use Amount:	912,043,269	984,018,374	912,271,554	886,967,956
Generated Byproduct Amt :	111,376,558	129,995,688	120,571,793	112,452,037
Shippped in/as Prod Amt :	322,071,300	429,851,250	399,218,574	436,032,013
TRI Information				
Total Emissions :	20,817,452	20,652,078	16,835,991	13,517,891
Discharge to POTW Amt:	3,188,882	2,108,972	2,359,296	2,228,071
Transfer Offsite Amt:	11,490,933	30,956,943	36,566,132	35,297,164
Total Releases and Transfers:	35,497,267	53,717,993	55,761,419	51,043,126
General Information				
Number of Facilities :	668	701	681	632
Number of Chemicals :	114	137	142	133
Number of Records :	2,021	2,265	2,225	2,044

Release Date:8/29/1995 Universe : Univ-7 Facility/Chemicals Reported in 92 and 93

	1990	1991	1992	1993
TURA Information				
Manufactured Amount :	25,733,774	15,147,099	17,352,985	15,130,314
Processed Amount :	760,579,552	827,361,280	818,429,801	790,179,667
Otherwise Used Amount :	133,968,288	146,635,108	181,756,123	173,094,085
Total Use Amount:	920,281,614	989,143,487	1,017,538,909	978,404,066
Generated Byproduct Amt :	111,872,608	130,622,119	139,379,676	132,716,389
Shippped in/as Prod Amt :	324,766,999	434,343,609	428,937,010	468,796,798
TRI Information				
Total Emissions :	20,821,663	20,659,178	16,977,157	13,611,612
Discharge to POTW Amt:	3,226,957	2,109,742	3,798,871	3,160,815
Transfer Offsite Amt:	11,502,824	31,334,264	37,223,604	35,999,058
Total Releases and Transfers:	35,551,444	54,103,184	57,999,632	52,771,485
General Information				
Number of Facilities :	670	702	694	647
Number of Chemicals :	119	142	153	143
Number of Records :	2,054	2,280	2,479	2,326

Release Date:8/29/1995 Universe : Univ-8 Fac/Chems First Reportable in 91

	1990	1991	1992	1993
TURA Information				
Manufactured Amount :	83,000	2,802,856	2,866,365	343,480
Processed Amount :	4,110,913	76,221,407	101,247,420	108,183,398
Otherwise Used Amount :	1,888,998	22,156,722	20,558,318	22,730,456
Total Use Amount:	6,082,911	101,180,985	124,672,103	131,257,334
Generated Byproduct Amt :	1,007,215	17,634,155	14,738,454	15,895,540
Shippped in/as Prod Amt :	3,897,405	58,871,049	78,359,952	100,046,714
TRI Information				
Total Emissions :	93,345	3,590,122	2,139,540	2,103,125
Discharge to POTW Amt:	0	377,256	480,643	701,104
Transfer Offsite Amt:	1,260	1,271,219	1,316,578	1,483,675
Total Releases and Transfers:	94,605	5,238,597	3,936,761	4,287,904
General Information				
Number of Facilities :	10	138	137	135
Number of Chemicals :	24	64	70	65
Number of Records :	31	296	317	323

Release Date:8/29/1995 Universe : Univ-9 Fac/Chems First Reportable in 92

	1990	1991	1992	1993
TURA Information				
Manufactured Amount :	118,815	2,359,960	5,986,335	8,464,142
Processed Amount :	2,988,870	2,748,113	59,157,581	43,623,026
Otherwise Used Amount :	5,130,660	17,040	40,123,439	39,348,942
Total Use Amount:	8,238,345	5,125,113	105,267,355	91,436,110
Generated Byproduct Amt :	496,050	626,431	18,807,883	20,264,352
Shippped in/as Prod Amt :	2,695,699	4,492,359	29,718,436	32,764,785
TRI Information				
Total Emissions :	4,211	7,100	141,166	93,721
Discharge to POTW Amt:	38,075	770	1,439,575	932,744
Transfer Offsite Amt:	11,891	377,321	657,472	701,894
Total Releases and Transfers:	54,177	385,191	2,238,213	1,728,359
General Information				
Number of Facilities :	31	15	212	237
Number of Chemicals :	5	5	11	10
Number of Records :	33	15	254	282

Universe 1 Data as Percent of All Universe 0 Data				
	1990	1991	1992	1993
Number of Facilities	96%	97%	96%	95%
Number of Chemicals	99%	99%	98%	97%
Number of Records	94%	95%	94%	94%
Manufactured Amount	99%	97%	92%	93%
Processed Amount	97%	97%	96%	93%
Otherwise Used Amount	89%	92%	95%	96%
Total Use	95%	96%	96%	94%
Byproduct Generated	97%	98%	96%	97%
Shipped in or as Product	89%	93%	93%	89%
Transfers to POTW	96%	87%	89%	80%
Transfers Offsite	97%	95%	92%	95%
TRI Releases	98%	99%	99%	98%
Total TRI	98%	96%	94%	95%

Universe 2 Data as Percent of All Universe 0 Data				
	1990	1991	1992	1993
Number of Facilities	49%	51%	52%	57%
Number of Chemicals	71%	72%	71%	77%
Number of Records	35%	36%	36%	41%
Manufactured Amount	51%	46%	42%	37%
Processed Amount	71%	69%	64%	64%
Otherwise Used Amount	32%	49%	49%	56%
Total Use	65%	66%	61%	62%
Byproduct Generated	43%	42%	42%	46%
Shipped in or as Product	60%	61%	58%	60%
Transfers to POTW	57%	40%	32%	33%
Transfers Offsite	43%	35%	36%	44%
TRI Releases	34%	38%	38%	43%
Total TRI	39%	36%	36%	43%

Universe 3 Data as Percent of All Universe 0 Data				
	1990	1991	1992	1993
Number of Facilities	63%	66%	67%	74%
Number of Chemicals	76%	77%	76%	83%
Number of Records	55%	56%	57%	64%
Manufactured Amount	85%	77%	64%	67%
Processed Amount	91%	89%	87%	86%
Otherwise Used Amount	78%	81%	82%	86%
Total Use	89%	88%	86%	86%
Byproduct Generated	81%	80%	80%	86%
Shipped in or as Product	84%	81%	80%	80%
Transfers to POTW	79%	64%	54%	59%
Transfers Offsite	73%	77%	76%	78%
TRI Releases	58%	65%	67%	76%
Total TRI	65%	72%	72%	77%

Universe 4 Data as Percent of All Universe 0 Data				
	1990	1991	1992	1993
Number of Facilities	67%	70%	71%	78%
Number of Chemicals	96%	98%	98%	97%
Number of Records	81%	83%	82%	86%
Manufactured Amount	98%	81%	93%	93%
Processed Amount	95%	95%	94%	94%
Otherwise Used Amount	93%	90%	90%	91%
Total Use	95%	94%	93%	94%
Byproduct Generated	94%	91%	93%	94%
Shipped in or as Product	90%	90%	90%	89%
Transfers to POTW	93%	85%	88%	84%
Transfers Offsite	91%	92%	89%	89%
TRI Releases	86%	86%	85%	86%
Total TRI	88%	89%	88%	88%

Universe 0 "Top 20" Facilities Data as Percent of All Universe 0 Data				
	1990	1991	1992	1993
Number of Facilities	4%	4%	4%	5%
Number of Chemicals	64%	65%	62%	56%
Number of Records	8%	8%	9%	9%
Manufactured Amount	75%	42%	28%	5%
Processed Amount	76%	72%	68%	69%
Otherwise Used Amount	38%	43%	42%	44%
Total Use	70%	68%	64%	65%
Byproduct Generated	40%	38%	38%	41%
Shipped in or as Product	57%	52%	47%	53%
Transfers to POTW	10%	21%	24%	18%
Transfers Offsite	19%	30%	37%	45%
TRI Releases	13%	13%	13%	15%
Total TRI	14%	24%	29%	37%

Universe 0 - Non "Top 20" Data as Percent of All Universe 0 Data				
	1990	1991	1992	1993
Number of Facilities	96%	96%	96%	95%
Number of Chemicals	91%	90%	91%	94%
Number of Records	92%	92%	91%	91%
Manufactured Amount	25%	58%	72%	95%
Processed Amount	24%	28%	32%	31%
Otherwise Used Amount	62%	57%	58%	56%
Total Use	30%	32%	36%	35%
Byproduct Generated	60%	62%	62%	59%
Shipped in or as Product	43%	48%	53%	47%
Transfers to POTW	90%	79%	76%	82%
Transfers Offsite	81%	70%	63%	55%
TRI Releases	87%	87%	87%	85%
Total TRI	86%	76%	71%	63%

Reality Check Facility Data as Percent of All Universe 0 Data				
	1990	1991	1992	1993
Number of Facilities	2%	2%	2%	2%
Number of Chemicals	45%	50%	47%	48%
Number of Records	5%	5%	5%	5%
Manufactured Amount	8%	5%	6%	8%
Processed Amount	3%	3%	3%	4%
Otherwise Used Amount	21%	12%	13%	13%
Total Use	6%	4%	4%	5%
Byproduct Generated	20%	20%	19%	21%
Shipped in or as Product	6%	4%	5%	6%
Transfers to POTW	30%	4%	5%	4%
Transfers Offsite	5%	18%	19%	21%
TRI Releases	14%	11%	12%	14%
Total TRI	12%	15%	16%	18%

This appendix includes the preliminary analysis of 'how a chemical is used' and results for Montreal Protocol chemicals. Chemicals included in each group are listed in Appendix C. Chemical categories were created depending on how a particular chemical was typically reported used. Because so many chemicals are both processed and otherwise used, the following categories were created: mostly processed including styrene, mostly processed and otherwise used, and mostly processed excluding styrene. A brief analysis of the chemical quantities reported and their trends over the four years is presented in the body of the report.

This appendix provides additional information for these categories as well as for Montreal Protocol chemicals. It also includes a sample report for analysis by chemical category. During the course of the study, this type of report was run for every chemical individually, as well as all chemical categories described in Appendix C.

The groups of processed and 'processed and otherwise used' chemicals exhibited different changes in levels of production as measured by the weighted average production ratio (PR_{wa}). In particular, because styrene comprised such a large percent of the quantities reported for processed chemicals, it was the determining factor for normalizing production levels for the entire group. As can be seen in Table J3-1, when styrene was excluded from the group, the PR_{wa} for 'processed' chemicals changed significantly.

The chemicals with styrene showed a decrease in production levels from 1990 to 1992 and a 3% increase in 1993. Those chemicals processed excluding styrene had a decrease in production levels from 1990 to 1991 but had increases of 17% and 15% in 1992 and 1993. The processed and otherwise used chemicals also had a decrease in production levels from 1990 to 1991 followed by an increase in production level of 5% and 14% in 1992 and 1993. The Montreal Protocol chemicals had changes in production levels that were opposite of all other chemicals. They had a 4% increase from 1990 to 1991 and then decreasing production in 1992 and 1993 of 2% and 5% respectively.

Production Ratios	91	92	93
Processed Chemicals with Styrene	0.939	0.942	1.03
Processed Chemicals without Styrene	0.922	1.176	1.15
Processed and Otherwise Used	0.944	1.047	1.142
Montreal Protocol Chemicals	1.044	0.981	0.947

Table J3-1 Chemical Groups Weighted Average Production Ratios

Figures J3-1 and J3-2 show the percent actual and normalized reductions for these four groups of chemicals. These figures suggest several conclusions about progress:

- styrene does affect the overall numbers for any group that it is in,
- Montreal Protocol chemicals appear to be making significant progress as measured by this methodology on both an actual and normalized basis,
- chemicals that are mostly processed appear to have a greater progress in reducing byproduct use than chemicals that are processed and otherwise used, and
- chemicals that are processed and otherwise used appear to have decreased in total use more than chemicals that are processed.

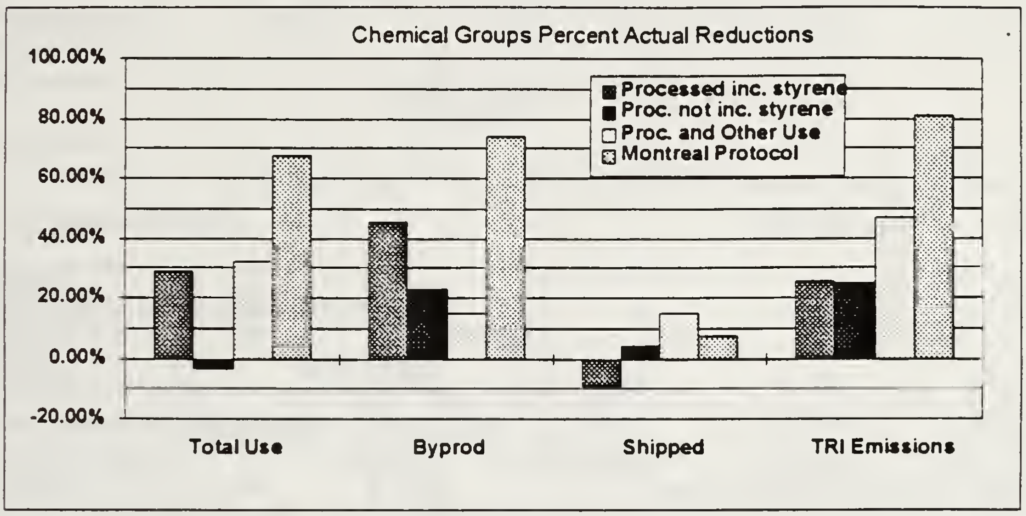

Figure J3-1

Montreal Protocol chemicals conclusions are not surprising. The Montreal Protocol chemicals are being phased-out of production for emissive uses. The reasons for the results for processed and otherwise chemicals is less obvious. If total use is declining for 'processed and otherwise used' chemicals, one would expect byproduct to decline as well. However, the Massachusetts definition of byproduct involves multiple counting of materials that are recycled on site when the recycling is not an integral part of the process. If more non-integral recycling were occurring, the total use would decrease but the byproduct would increase.

Additional analysis is needed in this area once the existing data issues are resolved and when the 1994 TURA data becomes available.

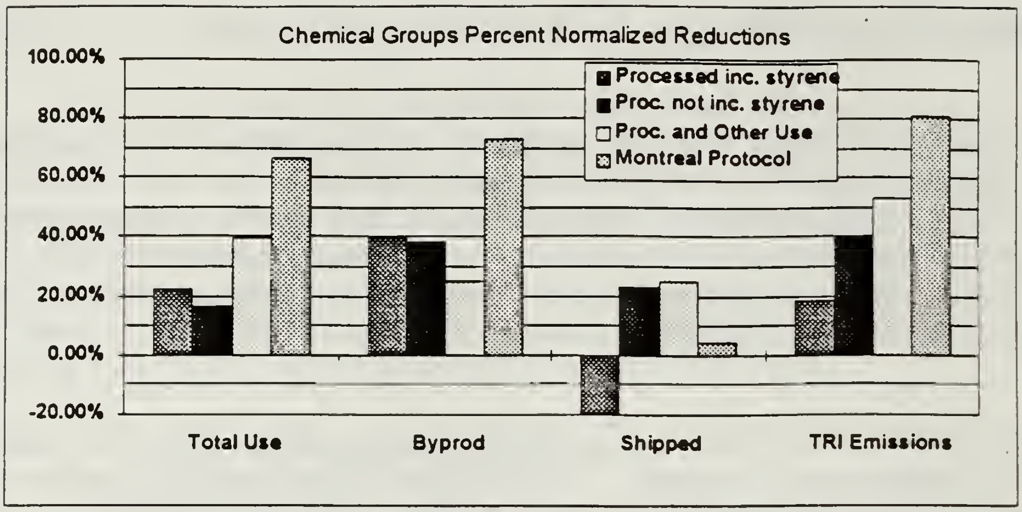

Figure J3-2

Universe	Percent Reductions 1990 to 1993			
	Byproduct		Total Use	
	Actual	Normalized	Actual	Normalized
Processed Chemicals with styrene	45%	40%	29%	22%
Proc. Chemicals without styrene	23%	38%	-4%	17%
Processed & Otherwise Used Chemicals	15%	25%	32%	40%

Table J3-2 Actual and Normalized Progress for Selected Universes

Release Date: 1/22/1996 Universe: All TURA All Reporting Facilities and Chemicals

Chemical Group : Montreal Protocol

	1990	1991	1992	1993
Chemical : BROMOCHLORODIFLUOROMETHANE (HALON 1211)			CAS Number :	353593
TURA Information				
Manufactured Amount	0	1,800,000	1,900,000	685,000
Processed Amount	0	0	0	0
Otherwise Used Amount	0	0	0	0
Total Use for Chemical	0	1,800,000	1,900,000	685,000
Generated Byproduct Amt	0	450	50,000	8,500
Shippped in/as Prod Amt	0	1,800,000	1,900,000	875,000
TRI Information				
Total Emissions :	0	450	4,900	3,000
Discharge to POTW:	0	0	0	0
Transfer Offsite:	0	0	0	0
Number of Facilities :	0	1	1	1
Chemical : BROMOMETHANE			CAS Number :	74839
TURA Information				
Manufactured Amount	0	0	17,811	17,460
Processed Amount	0	0	0	0
Otherwise Used Amount	18,200	18,200	18,200	42,788
Total Use for Chemical	18,200	18,200	36,011	60,248
Generated Byproduct Amt	65,074	18,200	36,000	60,088
Shippped in/as Prod Amt	0	0	0	0
TRI Information				
Total Emissions :	22,600	18,200	20,950	45,132
Discharge to POTW:	0	0	0	0
Transfer Offsite:	2,649	0	15,300	14,700
Number of Facilities :	2	1	2	2
Chemical : CARBONTETRACHLORIDE			CAS Number :	56235
TURA Information				
Manufactured Amount	0	0	0	0
Processed Amount	0	0	14,500	0
Otherwise Used Amount	0	0	0	0
Total Use for Chemical	0	0	14,500	0
Generated Byproduct Amt	0	0	144	0
Shippped in/as Prod Amt	0	0	13,356	0
TRI Information				
Total Emissions :	0	0	144	0
Discharge to POTW:	0	0	0	0
Transfer Offsite:	0	0	0	0
Number of Facilities :	0	0	1	0

Release Date: 1/22/1996 Universe: All TURA All Reporting Facilities and Chemicals

Chemical Group : Montreal Protocol

	1990	1991	1992	1993
Chemical : DICHLORODIFLUOROMETHANE			CAS Number :	75718
TURA Information				
Manufactured Amount	0	0	0	0
Processed Amount	0	16,929	32,278	0
Otherwise Used Amount	0	114,000	94,270	67,584
Total Use for Chemical	0	130,929	126,548	67,584
Generated Byproduct Amt	0	114,000	94,270	67,584
Shippped in/as Prod Amt	0	16,929	32,278	0
TRI Information				
Total Emissions :	0	113,900	94,720	67,584
Discharge to POTW:	0	0	0	0
Transfer Offsite:	0	0	0	0
Number of Facilities :	0	3	2	1
Chemical : FREON113			CAS Number :	76131
TURA Information				
Manufactured Amount	0	0	0	0
Processed Amount	1,699,165	2,086,999	1,945,736	1,034,142
Otherwise Used Amount	2,785,500	2,269,965	1,646,816	573,258
Total Use for Chemical	4,484,665	4,356,964	3,592,552	1,607,400
Generated Byproduct Amt	2,610,446	2,510,313	1,831,564	673,194
Shippped in/as Prod Amt	1,646,734	2,182,204	1,961,668	1,041,284
TRI Information				
Total Emissions :	2,204,766	1,791,514	1,378,495	440,918
Discharge to POTW:	10	0	0	0
Transfer Offsite:	136,234	434,705	347,046	157,089
Number of Facilities :	78	66	56	29
Chemical : TRICHLOROETHANEA			CAS Number :	71556
TURA Information				
Manufactured Amount	0	0	0	0
Processed Amount	10,452,455	12,072,946	11,980,669	6,936,198
Otherwise Used Amount	5,769,232	4,231,749	2,911,594	852,502
Total Use for Chemical	16,221,687	16,304,695	14,892,263	7,788,700
Generated Byproduct Amt	5,464,512	5,182,185	3,822,171	1,355,683
Shippped in/as Prod Amt	10,125,865	11,889,884	11,959,832	12,922,349
TRI Information				
Total Emissions :	3,815,433	2,925,197	2,036,765	651,363
Discharge to POTW:	7,691	13,849	7,209	262
Transfer Offsite:	511,964	1,347,114	948,677	272,200
Number of Facilities :	148	128	98	49

Release Date: 1/22/1996 Universe: All TURA All Reporting Facilities and Chemicals

Chemical Group : Montreal Protocol

Chemical : TRICHLOROMONOFLUOROMETHANE CAS Number : 75694

	1990	1991	1992	1993
TURA Information				
Manufactured Amount	0	0	0	0
Processed Amount	0	1,149,922	1,848,510	1,192,048
Otherwise Used Amount	0	23,000	0	0
Total Use for Chemical	0	1,172,922	1,848,510	1,192,048
Generated Byproduct Amt	0	83,198	67,441	86,027
Shippped in/as Prod Amt	0	1,089,723	643,054	0
TRI Information				
Total Emissions :	0	82,949	64,700	86,386
Discharge to POTW:	0	0	0	0
Transfer Offsite:	0	241	2,620	255
Number of Facilities :	0	5	4	1

Chemical : TRIFLUOROBROMOMETHANE CAS Number : 75638

	1990	1991	1992	1993
TURA Information				
Manufactured Amount	0	0	0	0
Processed Amount	0	0	252,533	174,506
Otherwise Used Amount	0	0	0	0
Total Use for Chemical	0	0	252,533	174,506
Generated Byproduct Amt	0	0	1,720	880
Shippped in/as Prod Amt	0	0	250,813	173,626
TRI Information				
Total Emissions :	0	0	1,720	880
Discharge to POTW:	0	0	0	0
Transfer Offsite:	0	0	0	0
Number of Facilities :	0	0	1	1

Grand Total Quantities for All Selected Chemicals

TURA Information	1990	1991	1992	1993
Total Manufactured Amount	0	1,800,000	1,917,811	702,460
Total Processed Amount	12,151,620	15,326,796	16,074,226	9,336,894
Total Otherwise Used Amount	8,572,932	8,572,932	4,670,880	1,536,132
Total Use all Chemicals:	20,724,552	23,783,710	22,662,917	11,575,486
Total Generated Byproduct Amt	8,140,032	7,908,346	5,903,310	2,251,956
Total Shippped in/as Prod Amt	11,772,599	16,978,740	16,761,001	15,012,259
TRI Information				
Total Emissions:	6,042,799	4,932,210	3,602,394	1,295,263
Discharge to POTW Amt:	7,701	13,849	7,209	262
Transfer Offsite Amt:	650,847	1,782,060	1,313,643	444,244
Number of Facilities:	204	180	144	72
Number of Chemicals :	3	6	8	7

This appendix includes a sample report of the industry segment analyses. Reports were printed out for 'user segment' groups, with subtotals at the 2-digit SIC code level. For example, the attached facility-wide SIC report is for the 2-digit SIC code '36', Electronic and Other Electric Equipment. The first set of quantities is for 'user segment' group 36, which consists of all facilities which are in the 2-digit SIC but not included in one of the other, more detailed groups following. Those groups following, 3672 and 3674, were separated out in the user segment classification scheme because of the number of firms and similarity of processes and products in each. The final section is the total for the 2-digit level SIC '36'.

This report was run for all user segment groups, both using facility-level and production unit-level SIC codes.

	1990	1991	1992	1993
SIC Group : 36 Electronic & Other Electrical Equipment				
TURA Information				
Manufactured Amount :	386,070	1,236,206	2,581,083	1,756,343
Processed Amount :	18,180,704	27,426,326	24,875,428	22,027,719
Otherwise Used Amount:	8,075,356	6,948,290	9,397,411	7,232,174
Total Chemical Use	26,642,130	35,610,822	36,853,922	31,016,236
Generated Byproduct Amt:	10,877,877	11,179,556	11,204,038	7,308,460
Shippped in/as Prod Amt:	13,742,209	16,267,762	18,319,633	13,543,889
TRI Information				
Total Emissions:	3,649,514	3,652,554	2,327,696	1,166,237
Discharge to POTW Amt:	205,536	160,654	168,915	131,137
Transfer Offsite Amt:	1,348,359	4,231,056	4,285,473	3,140,114
Number of Facilities:	64	56	50	40
Number of Chemicals	41	46	46	45
Number of Records	200	185	186	140
SIC Group : 3672 Printed Circuit Boards				
TURA Information				
Manufactured Amount :	40,183	120,797	240,450	219,974
Processed Amount :	898,293	969,076	921,055	1,212,916
Otherwise Used Amount:	2,025,223	1,446,108	2,112,656	2,091,094
Total Chemical Use	2,963,699	2,535,981	3,274,161	3,523,984
Generated Byproduct Amt:	2,098,927	1,899,926	2,526,192	2,542,065
Shippped in/as Prod Amt:	365,259	285,213	269,057	287,116
TRI Information				
Total Emissions:	310,548	250,100	294,134	88,999
Discharge to POTW Amt:	75,465	46,150	46,483	38,625
Transfer Offsite Amt:	188,845	691,302	857,372	846,245
Number of Facilities:	18	16	14	14
Number of Chemicals	12	12	12	13
Number of Records	57	46	52	67
SIC Group : 3674 Semiconductors & Related Devices				
TURA Information				
Manufactured Amount :	0	1,813	621	2,245
Processed Amount :	84,818	81,484	77,545	35,867
Otherwise Used Amount:	2,048,733	2,749,103	4,318,891	4,514,987
Total Chemical Use	2,133,551	2,832,400	4,397,057	4,553,099
Generated Byproduct Amt:	864,033	2,584,438	2,639,351	2,235,742
Shippped in/as Prod Amt:	8,300	9,370	0	0
TRI Information				
Total Emissions:	240,020	239,269	137,430	101,513
Discharge to POTW Amt:	990	1,007	85	999
Transfer Offsite Amt:	225,493	239,391	217,170	131,020
Number of Facilities:	12	11	12	10
Number of Chemicals	19	17	17	15
Number of Records	54	46	51	42

Release Date: 1/22/1996 Universe : All TURA All Reporting Facilities and Chemicals

	1990	1991	1992	1993
	Total for SIC Codes Selected			
TURA Information				
Manufactured Amount :	426,253	1,358,816	2,822,154	1,978,562
Processed Amount :	19,163,815	28,476,886	25,874,028	23,276,502
Otherwise Used Amount :	12,149,312	11,143,501	15,828,958	13,838,255
Total Chemical Use	31,739,380	40,979,203	44,525,140	39,093,319
Generated Byproduct Amt:	13,840,837	15,663,920	16,369,581	12,086,267
Shippped in/as Prod Amt :	14,115,768	16,562,345	18,588,690	13,831,005
TRI Information				
Total Emissions:	4,200,082	4,141,923	2,759,260	1,356,749
Discharge to POTW Amt:	281,991	207,811	215,483	170,761
Transfer Offsite Amt:	1,762,697	5,161,749	5,360,015	4,117,379
Number of Facilities:	94	83	76	64
Number of Chemicals:	43	49	49	50
Number of Records:	311	277	289	249

Changes in Form S reporting could be made which would both reduce the reporting burden on Massachusetts companies and improve the accuracy of reported information. These changes and improvements include the following:

- **Provide for electronic reporting of Form S and Form R**, or at a minimum the Form R, since there is already a program available from the EPA to do this. The EPA program would need to be modified to allow entry of non-TRI chemicals. If computerization of the Form S is not possible, a version of the Form S in several standard word processor formats could be made available to reduce the amount of time required to report, since the forms could be filled out and edited on computer rather than by hand.

- **Provide facilities with feedback on data reported in prior years** to simplify the reporting process and improve the quality of the TURA data. At the beginning of each reporting cycle (approximately January of each year, but by the end of March at the latest), provide each facility that reported in the last year a concise report showing all the major data elements the facility reported for all prior years. A report which listed data elements for all 4 years together was used to review the reporting history of Reality Check facilities. The report made it easy to spot year to year inconsistences and check figures in the DEP database with figures on the original Form S submitted to the state. The TURA program could send TURA filers such a report with advice to check these numbers and correct any errors or inconsistencies. Such a process would improve the accuracy of the TURA database and potentially be a benefit to TUR Planners.

- **Include a pre-printed label** in the reporting package of all facilities that reported in a prior year including the facility ID, address, and TRI ID or indication that the facility is a state-only filer and request that the facilities use the label to submit the current year's form with corrections to the label as necessary.

- **Increase TUR Planner education regarding Form S reporting**. Offer more instruction to TUR Planners on the need for accurate data, how to calculate data elements, and the benefits of reviewing data as part of the planning process.

- **Eliminate any unnecessary sections of the EPA Form R**. For firms with many CERCLA chemicals, the requirement to submit a Form R (CERCLA Chemicals are not required to be reported under EPCRA) significantly increases the amount of paper work since Form Rs are several pages long and have very detailed data elements. If not all the data is being used, it would reduce the reporting burden to have some sections eliminated.

There are also changes which could be made to Form S reporting which would greatly simplify the useability of the data for measuring progress and other types of analysis. These changes include the following:

- **For newly reportable chemicals and industries, request estimate of 1987 quantities** in order to maintain a 1987 baseline. When a facility reports a chemical for the first time, they should be requested to also submit an estimate of the use and byproduct for the chemical in 1987. This would provide continuing information for maintaining the 1987 baseline.

- **Include TRI ID number on Form S** and in FMF database, and in the FMF and extract file databases, for facilities that report both federally and under TURA. This will simplify matching TURA filers and TRI filers. For non-TRI TURA facilities include a specific indication that the facility is a state-only filer and include this in the database.

- **Include a facility-level SIC code on the Form S** or use the facility-level SIC code from the Form R in the database at the facility level. Facilities should be requested to review their facility-wide SIC code for appropriateness and accuracy.

- **Clarify instructions for TUR codes** and include a TUR code category "unknown reasons for change," Also, clarify instructions to reduce confusion between reporting BRI measured from a base year, but TUR codes if BRI has changed by more than 5 percent from the previous year.

- **Require designation of a wastewater treatment production unit** when wastewater treatment is responsible for more than 50% of a chemical's use. The SIC code for the unit should be the same as the facility-level SIC or the production units that are the major contributors of waste to the unit.

- **Revise optional section for 'reasons that a chemical is not longer reported'** so that it is required and so that it is clear whether TUR was responsible for reductions below thresholds. Make section 3 of the Form S coversheet *Chemicals that were Previously Reported that are not Reportable This Year* a required section and change reason codes for not reporting so that it is clear if the change is due to TUR or other factors.

- **Require facilities to provide some data (with no associated fee) for the year in which a facility or chemical drops below the threshold.** When a facility no longer reports a chemical because it has dropped below the threshold it would be helpful to have a report on the amount of use and byproduct in the first year not reported. This would allow for a more complete measure of progress or at least an indication (range) of use and byproduct generated.

- **Improve metal bender exemption reporting** to clarify for which metals an exemption is being requested.